MAY 14, 1959

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY

DESIGN ENGINEERING SHOW GUIDE

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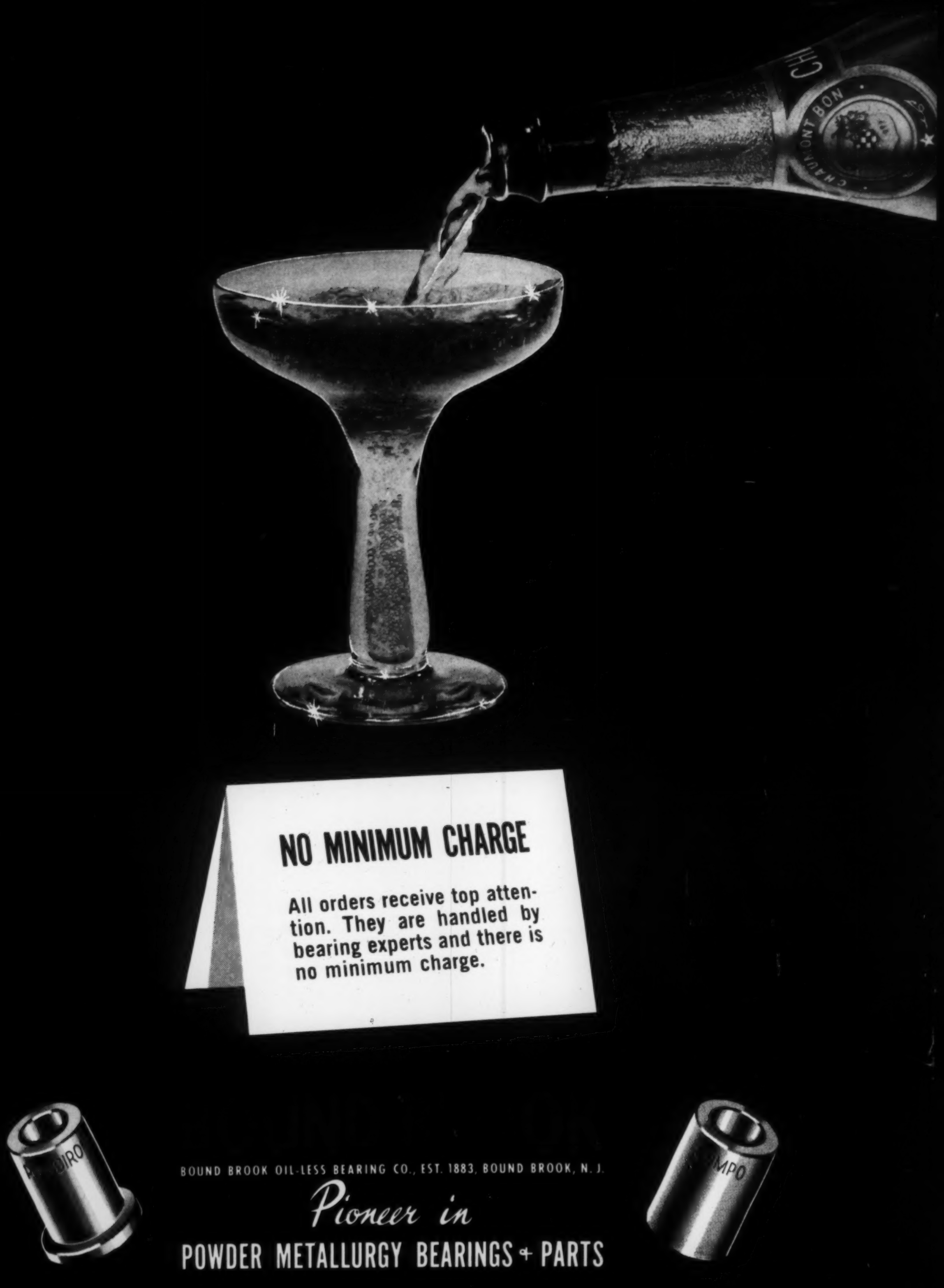
FARNSWORTH



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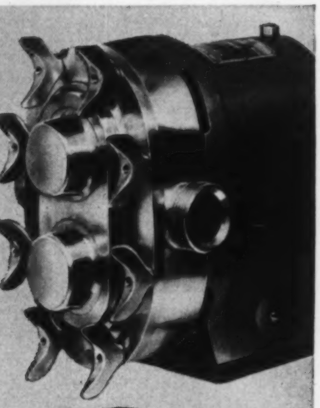

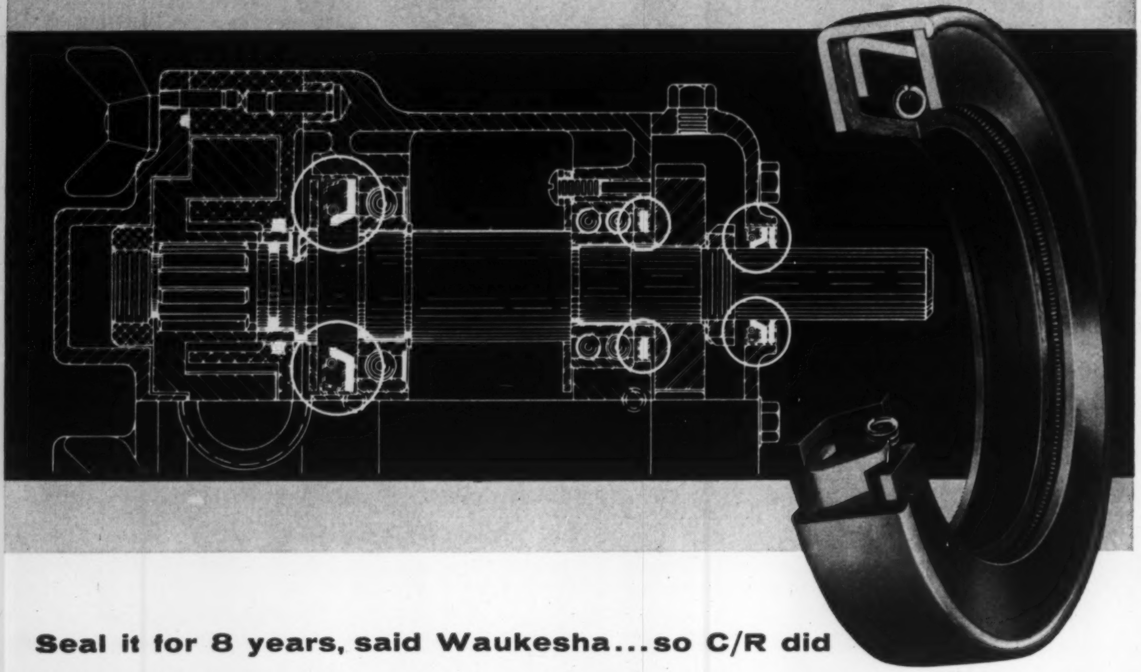

Seal it for 8 years, said Waukesha...so C/R did

"And, we might add, we have had very, very few instances of failure with C/R Oil Seals," says Mr. Gilbert R. Funk, Vice President, Pump Division of the Waukesha Foundry Co. Long service life is only one of the requirements met by the C/R Types P, G and A Oil Seals in this Waukesha Sanitary Pump. They must seal effectively eight hours a day, six days a week for eight years . . . at shaft speeds up to 750 r.p.m., with pump head pressures up to 150 p.s.i., and temperatures ranging from 0° to 220° F., depending on the food material pumped. They also must resist food acids, and the acids and alkalies in the commercial detergents used to cleanse and flush the pump daily. An added indication of C/R Oil Seal dependability in the Waukesha Sanitary Pump is the fact that it constantly must meet rigid 3-A Sanitary Standards for the Dairy and Food Industries. If you have a sealing problem . . . equally critical . . . or simple . . . bring it to Chicago Rawhide. C/R engineers will help you select the correct oil seal for your application from stock . . . or cooperate with you on special designs.

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OIL SEAL C/R DIVISION
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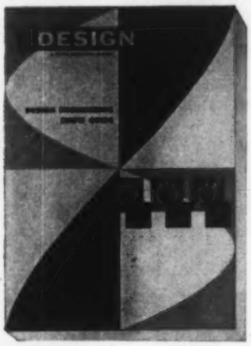

Front Cover: To show the broad scope of design engineering, artist George Farnsworth has combined mechanical, electrical, and hydraulic symbols with materials cross sections and sine and cosine curves. The cover keynotes this Design Engineering Show issue; guide to Show starts on Page 199.

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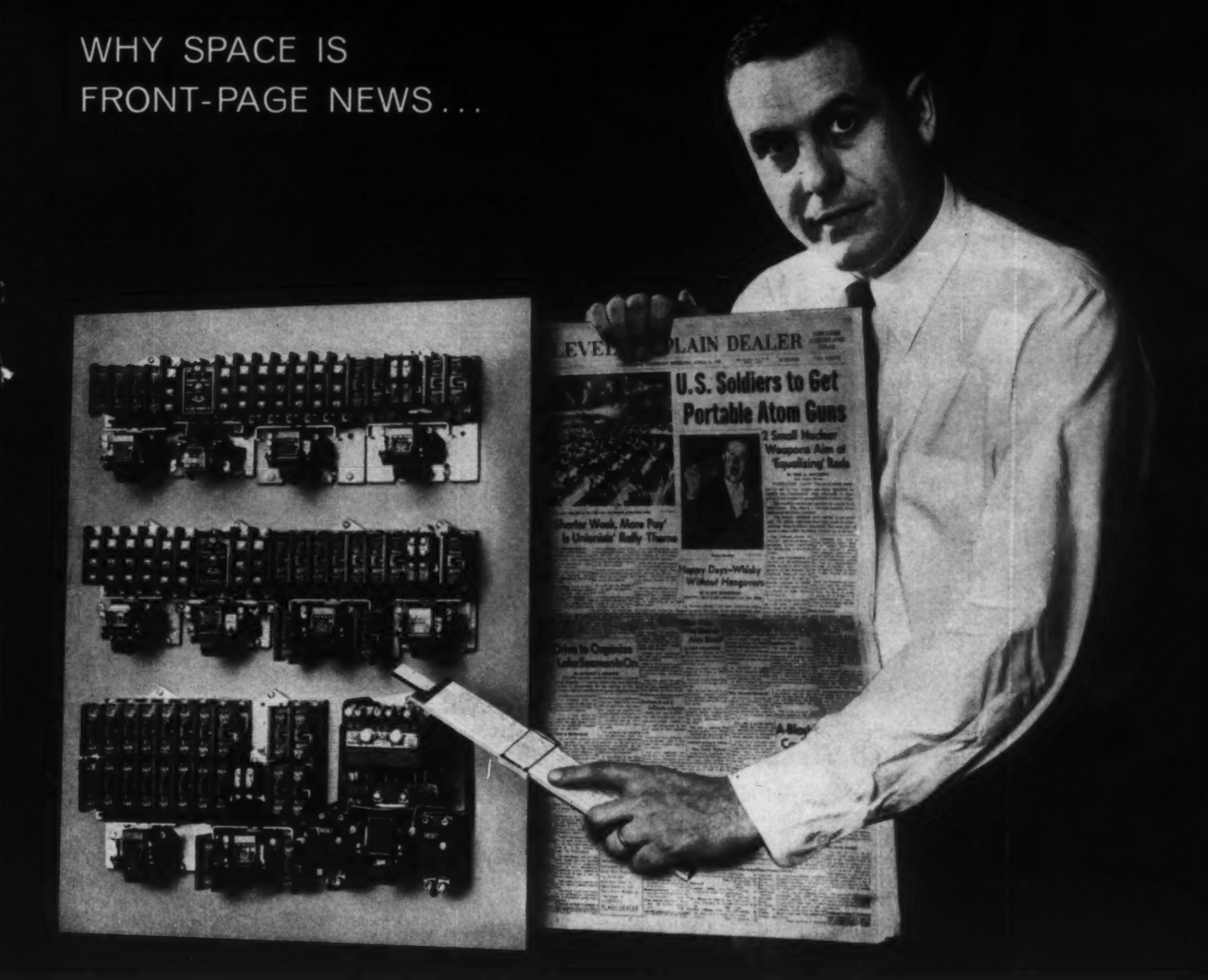
WHY SPACE IS
FRONT-PAGE NEWS...
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U.S. Soldiers to Get
Portable Atom Guns
2 Small Nuclear Weapons Aim at 'Equalizing' Reds
Shorter Week, More Pay' Is Unionists' Rally Theme
Happy Days—Whisky Without Hangovers
Drive to Organize Lake Seamen Is On

Compact Clark Relays control 72 circuits from panel area smaller than a newspaper

In this day of space exploration and space economy, it's news—front page news—when you can get 72 separate, controlled circuits all on a panel no larger than 15" x 20".

Clark Controller, with the most complete and integrated line of control relays available today—convertible pole, latch, universal pole, and time delay—does it! And only Clark offers such a wide range of operation, so many contacts, in a panel area of such small size.

Shown mounted here with the Clark Size 1, Type "CY" Starter are 10 compact Clark Relays which include four time delay contacts (two normally open, two normally closed), 52 instantaneous contacts (14 normally open, 14 normally closed, and 24 convertible), plus 16 latching contacts (all convertible).

The same engineering leadership and superior workmanship that made Clark Controller the *standard of quality* for controls in heavy industry, is inherent in the broad line of Clark Relays for modern panels.

The "modular construction" of all Clark "PM" Relays insures integrated uniformity, compactness and flexibility. Functional alignment in mounting results in neater, more uniform panels and most efficient utilization of valuable space. And because "PM" relays are available in a wide variety of pole combinations, providing up to 14 contacts on a single relay, you can control more circuits—save on relay requirements.

For more information on the complete line of Clark "PM" Relays which is making space-saving headlines, contact your nearest Clark Controller sales office or distributor. Or, write direct to Clark Controller for free bulletins.

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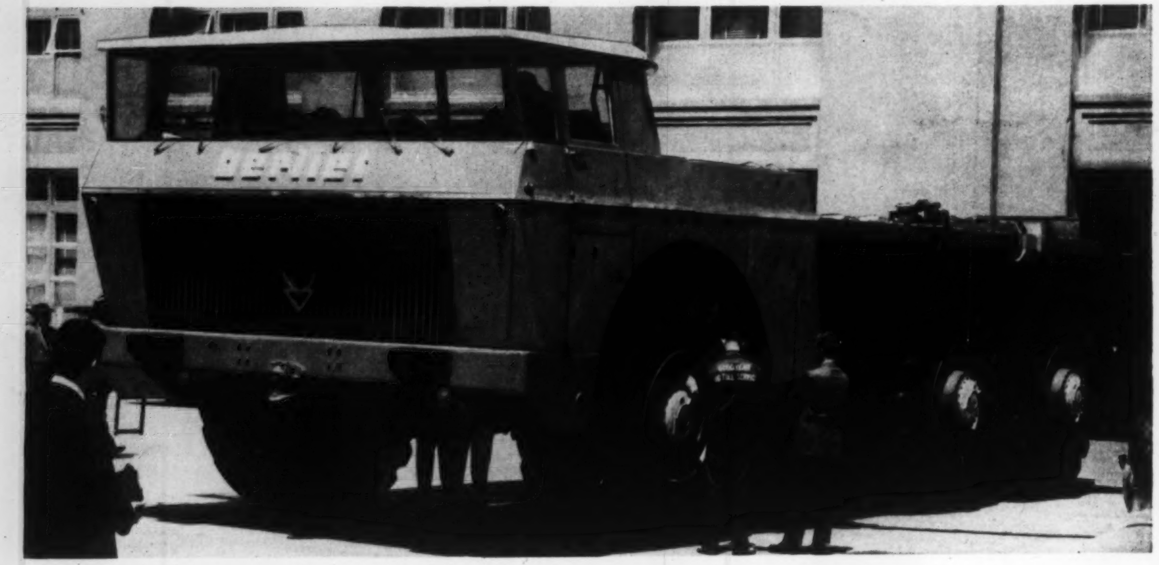
MACHINE DESIGN

ENGINEERING NEWS



French Accent: Light Tread and Comfort in the Cab

World's largest truck, a flat-bed designed for off-the-road hauling of 100-ton payloads, rides as lightly on the ground as an unloaded camel. Bearing area of its six, 8-ft diameter tires totals 100 sq ft, which, for a 100-ton truck, results in a ground pressure of 14 psi. An average camel's foot exerts the same pressure, says Goodyear Tire & Rubber Co., who designed the tires. Built by Automobiles M. Berliet, Lyons, France, the truck is 41 ft long, 16 ft wide, and 13 ft high. It's powered by a 600-hp turbodiesel engine, with eight speeds forward and eight in reverse. The cab ("Cabine Relaxe") is equipped with a filtered air conditioner, five-abreast seats, two sleeping berths, a cooking range, two-way radio, and drinking-water tanks. The big vehicle was imported by an Oklahoma oil prospector.

Solid-Fuel Rocket Powers Loudspeaker with a Larynx

Big Voice Called SAM Will Gab while 'Chuting

MENLO PARK, CALIF.—The world will be hearing a lot of SAM in the future. He is about the loudest loudspeaker in his size class.

SAM — The Stanford Airstream Modulator, a speaker system developed at Stanford Research Institute —works like the human voice. Instead of electric impulses vibrating a diaphragm, a stream of compressed air is modulated to produce sound. Solid rocket fuel can also be used, instead of the compressed air. In this case, the fuel is burned under controlled conditions, and the vapors are mixed with ammonia. The result is a mixture with the same density and temperature as air, a mixture which can make SAM talk most efficiently.

SAM's message comes either from a tape recorder within the assembly, or from a broadcast, via a radio receiver. He can be heard for a distance several times that of a conventional loudspeaker of the same weight.

One model has been mounted on a helicopter for directing ground troops or for use during floods and other emergencies. A second is parachute-borne. After release from a plane SAM drops slowly from 4000 ft, talking loudly for about five minutes. The device may be used for propaganda purposes, and for reaching inaccessible areas by voice.

A third model is SAM-in-a-Siren. This modification is for civil defense or for emergencies such as tornadoes. A siren sounds, alerting the populace to danger. The air supply of the siren is then switched to a modulator unit for voice reproduction. The siren gives the proper instructions to persons in a wide area.

SAM's capability for producing high-intensity sound may lead him to still another job. The metals of modern airplanes are subjected to test to study "sonic fatigue" of metal structures. SAM may substitute for jet engines, one of the noise sources presently used.

Other uses for SAM are being developed. He may be used as a smog fighter, as part of a church organ, or wherever big noise is needed.

An announcement of interest to manufacturers of steel parts

Improvements in today's STRESSPROOF STEEL BARS WITH COPPER

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Best Break-In for Engineers: Work and Responsibility

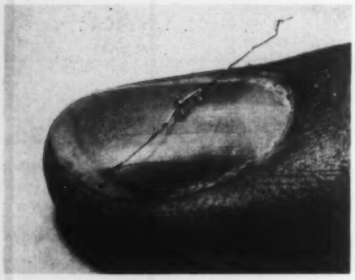
ANN ARBOR—Young college scientists and engineers should be given responsibility for a specific assignment soon after they are employed by industry, a University of Michigan industrial relations expert believes. Prof. John W. Riegel, director of the U-M Bureau of Industrial Relations, says information pertaining to company organization, personnel policies, etc., can be presented on a part-time basis over a number of months—while the new man is engaged in some practical and profitable (to the company) work.

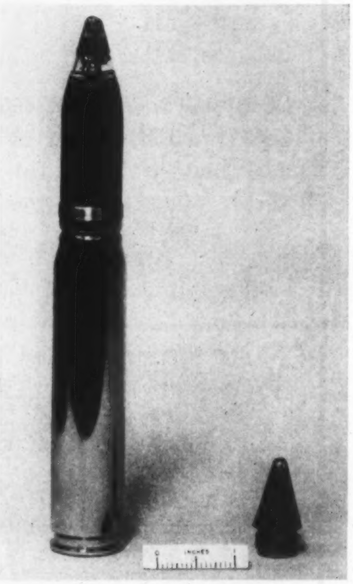
"In this way, ability to perform specific assignments will be tested, and so will other important characteristics. Also the new engineer will be more fully earning his way under the usual employment conditions."

As soon as the gradute becomes familiar with his company and his work, Riegel believes individual programs for self - development should be started. He emphasizes that these will be successful only when individual motivation is high, and suggests these helpful steps:

- Provide for a written semiannual or annual progress report. Here, the new engineer can summarize the work he has completed, state his goals for the coming period, and indicate the types of experience which he would like to have to improve his abilities and qualifications.
- Have the new graduate's immediate superior and one or two other senior persons familiar with his work, review his background and achievements and select types of experience which would be beneficial.
- Give those engaged in research and development a chance to see how their ideas are applied elsewhere in the company and become familiar with operating conditions and personnel.
- Assign each individual a variety of problems, over a period of time, and have him work under different supervisors.
- Encourage exchange of ideas among professionals through technical department meetings, seminars, and scientific sessions.
- Share part of the expenses involved in obtaining advanced degrees and in attending professional meetings.

Prof. Riegel's ideas are based on a recent study of relations of scientists and engineers with their managers in ten large companies.





Two Tiny Tools

An electric lamp the size of a pinhead and a radio transmitter slightly larger than a pencil eraser have been developed by Army's Diamond Ordnance Fuze Laboratories, Washington. The lamp, above, measures 0.03 in. diam by 0.1 in. long and uses 40 ma current at 1.5 v. It will find use as a probe-tip light, as a control-panel dial light, and where a near-point source of light is needed. The transmitter, right, is primarily intended for ballistic studies, although other applications are also apparent. Mounted in an artillery-shell head, it will transmit temperature data when the shell is in flight.

Topics

Car built to roll with the punch of a collision is a two-section affair which pivots in the middle. Meaningfully named the Sir Vival and labeled a "safety first" automobile by its maker (Hollow Boring Corp., Worcester, Mass.), it has engine, headlights, and front wheels in the fore section, which is connected by a vertical axle to the rear coach section. Here, the driver sits in an elevated, glass-enclosed cockpit; behind the driver is space for three passengers and baggage. Present price of the Sir Vival is $10,000, but this could drop to $6000 if demand were to sustain one-a-day production.

• • •

Waste watchers will collect information on the fate of packages of radioactive waste material dropped into the ocean off the New England coast. Skin divers carrying cameras loaded with color film will watch the descent of packages containing a dye instead of real atomic waste; if the package leaks, the dye will provide photographic evidence. The Atomic Energy Commission wants to know whether its containers remain intact, break open, gradually disintegrate, or are buried in the bottom of the sea. Study is also aimed at determining the best disposal areas and methods.

• • •

A tire without air obviously cannot have a blowout. With this fact in mind, researchers at American Latex Products Corp., Los Angeles subsidiary of Dayton Rubber Co., have developed a foam-filled, blowout-proof tire. The casing is filled with a flexible polyurethane material which can be bonded to the casing without the use of pressure equipment. Road testing of the tire reveals "no noticeable loss of stability or riding comfort," even after abuse such as firing bullets into the tire and drilling and sawing it.

• • •

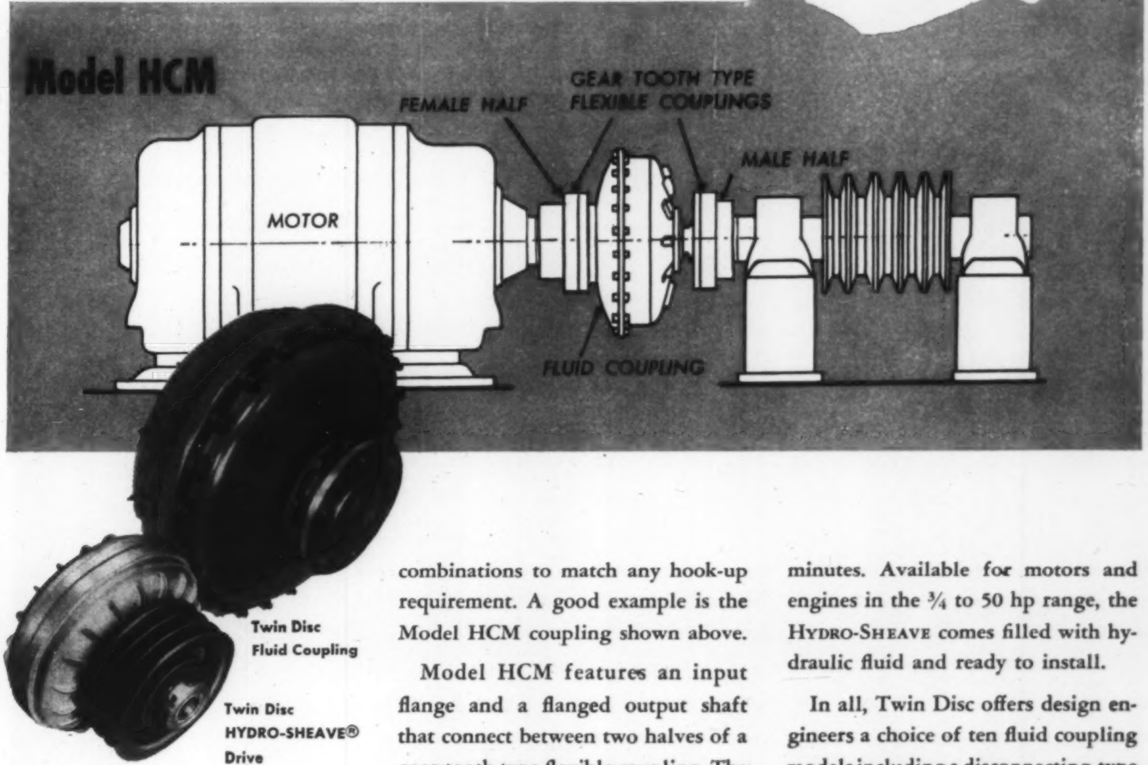
High-fly television will soon be furnished to first-class passengers on Continental Airlines' 707 jet planes. Reception is said to be fine at 35,000 ft.

• • •

News to warm the hearts of automobile owners is the development of a new, inexpensive method of heating. An Englishman is applying the electric-blanket heating principle to covers of car seats. His chair heater, already used in furniture, operates on very low voltage, and the heating element runs through nonflammable plastic foam. The heater will provide 80 or more hours of heat for about a penny's worth of current.

MEMO to drive line designers:

Twin Disc Fluid Couplings give you all the benefits of fluid drive *PLUS* easy installation . . .



Working between engine or motor and driven equipment, Twin Disc Fluid Couplings provide performance benefits aplenty . . . benefits such as satin-smooth power flow, protection against shock loads, full transmission of input torque, and elimination of engine lugging and motor burnouts.

Here's another big advantage that's sometimes overlooked: Twin Disc Fluid Couplings are exceptionally easy to apply and install. They come in a wide variety of input-output combinations to match any hook-up requirement. A good example is the Model HCM coupling shown above.

Model HCM features an input flange and a flanged output shaft that connect between two halves of a gear-tooth type flexible coupling. The result is an extremely compact arrangement with minimum distance between driving and driven shafts (see diagram). Model HCM is available in nine sizes from 7.4S to 21 with capacities from ¾ to 500 hp.

A special integrated power transmission package is Twin Disc's Hydro-Sheave® Drive. This low-cost conversion device has a tapered hub that permits the use of a wide range of quick-detachable V-belt sheaves. It can be installed in less than five minutes. Available for motors and engines in the ¾ to 50 hp range, the Hydro-Sheave comes filled with hydraulic fluid and ready to install.

In all, Twin Disc offers design engineers a choice of ten fluid coupling models including a disconnecting-type and a fluid power take-off.

Write our Rockford office for Bulletin 144-D.

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Hydraulic Division, Rockford, Illinois

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Contactless Relays Upgrade High-Current Line Protection

Static-Component Devices Outperform Mechanical Models

SEMICONDUCTOR relays—operating without springs, contacts, or other moving parts—have invaded the power-transmission field. With simultaneous announcements, two big names in the business—Allis-Chalmers Mfg. Co. and General Electric Co.—have released details of significant advances in the control of heavy-duty currents by static relays.

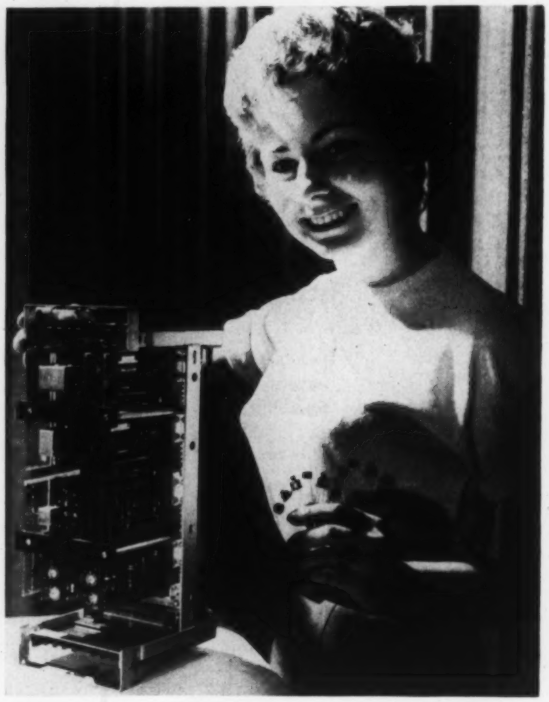
Employing semiconductor components throughout, both new units have been designed to increase the reliability, speed, and flexibility of protective-relay systems. They're heralded as the most significant advance in protective components since the original high-speed relay of 30 years ago. Elimination of all moving parts in the new units rules out the necessity for rigid testing, adjustment, and maintenance procedures required with mechanical-type relays. Other advantages:

- Reduced line-fault damage because of high-speed action of static components.
- Better co-ordination of related units under shifting load conditions.
- Quick reset with self-adjusting capabilities.
- Low-level fault detection, permitting heavier line loads with full protection.

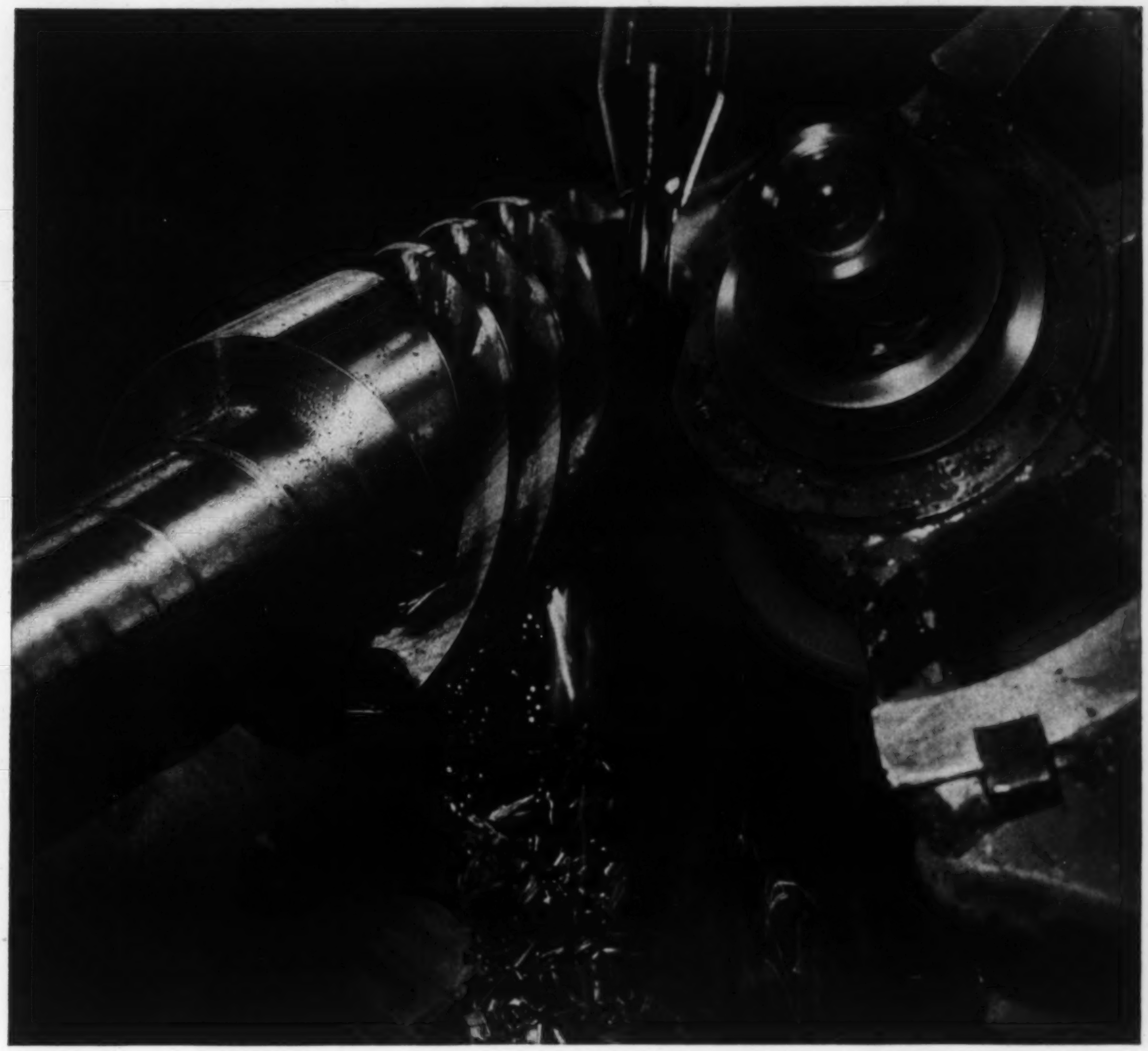
The Allis-Chalmers overcurrent relay, designed as a building-block unit, is basically an inverse-time unit connected in series with a pulsing-type switching stage. Accepting relatively low-power input, the relay assembly functions as an amplifier for operating heavy-duty circuit breakers. Added to the basic unit, an auxiliary voltage-restraining unit can be designed to respond to current, power, or phase angle, or may act as a transducer for translating quantities like pressure, temperature, etc., into discrete signals. The Allis-Chalmers overcurrent relay will be available in limited quantities this summer. Additional types will be introduced as rapidly as development models can be adapted for production.

The new General Electric protective relay is presently produced as a phase-sensing unit. It compares phase angles of currents entering and leaving a line section and provides high-speed simultaneous tripping of transmission-line circuit breakers when faults occur. Speed of the operation is extremely high—within $1\frac{1}{2}$ cycles after the fault is detected. Adaptation of the new semiconductor equipment to multiterminal transmission lines requires no major changes in the protective-relay system. According to GE, the transistorized unit has completed exhaustive field tests on the Muskingum-Philo 138 kv line of the Ohio Power Co.

Temperature-stabilized components in Allis-Chalmers' semiconductor overcurrent relay (inverse-time type) are shockproof and impervious to moisture. Plug-in design simplifies installation. Neon indicating lights, replacing conventional mechanical target indicators, signal instantaneous and time-trip actions. Front-mounted controls permit fast resetting of time and current ranges.



Phase-comparison relay — first in General Electric's new static-relay line—is designed for protection of high-voltage transmission lines and power-system components. Semiconductors, which are temperature compensated, are protected from spurious transient disturbances by surge-supression circuits. High sensitivity of the phase-sensing relay permits detection of low-magnitude faults.



Aristoloy leaded user reports 25% reduction in time required to cut worm gear threads

Cutting threads on worm gears is an expensive, time consuming operation. Geometry is critical and a considerable amount of metal must be removed. One of the large manufacturers of "worms," desiring to increase production, found that by switching to a *leaded* steel* he could increase both speeds and feeds. Equally important, expensive cutting tools lasted longer because of the freer machining characteristics of leaded steel—delivering more pieces between grinds, and drastically reducing down-time for tool changes.

Strength and hardness tests on the finished part, after heat treating, indicated no detectable difference in physical properties from unleaded grades previously used.

For complete information about Aristoloy leaded or standard analyses carbon, alloy, and stainless grades, write for booklet entitled, "A Complete Line of Leaded Steels," and new Products & Facilities Catalog. *Inland Ledloy License

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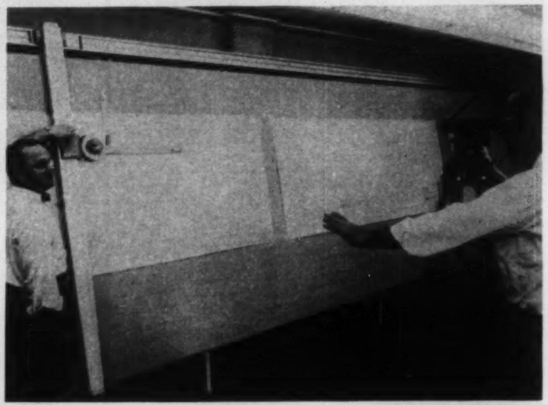
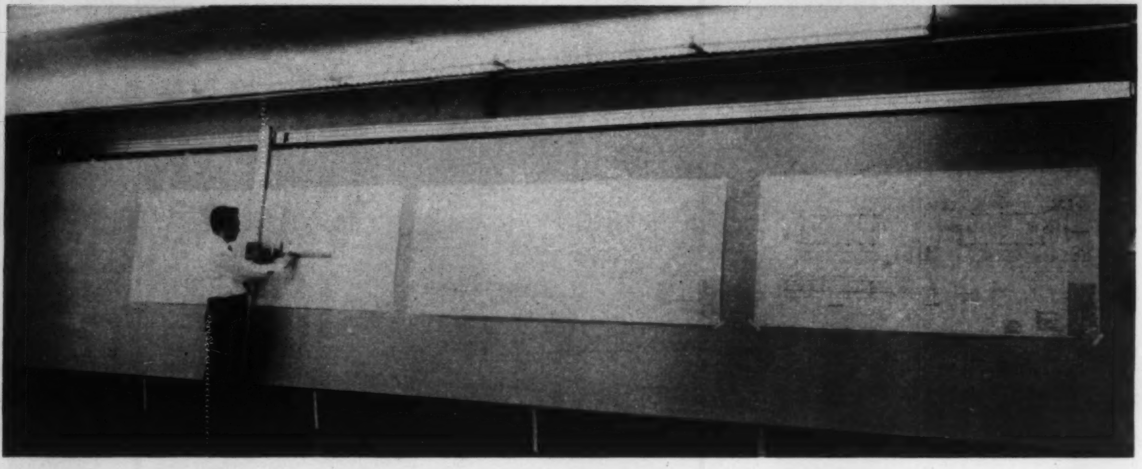
28-ft Drafting Machine Projects Views to 0.007-in. Accuracy

Full-scale pattern drawings and part templates for automobiles, aircraft, farm equipment, and big machinery are easily and accurately made with this 28-ft drafting machine. It's mounted on a fixed-position 30-ft board. The huge installation permits long line drawing and projection without repeated repositioning of scales to measure distances. It also eliminates errors that might occur in blowing up small-scale drawings. As an added advantage, the machine is designed so that extra Y-beams can be added to the same X-beam. This permits several men to work on the same set of drawings, completely co-ordinated as to lines, angles, and measurements. Tested with a transit, right, the installation proved to be accurate to within 0.007 in. (straight line across the board). Universal Drafting Machine Corp., Cleveland, built the machine for Aeromotive Designers Inc. According to Universal, the 28-ft model is the first standard drafting machine that permits large-scale X-Y layout and plotting. And despite the machine's precision and size, it is relatively low-cost.





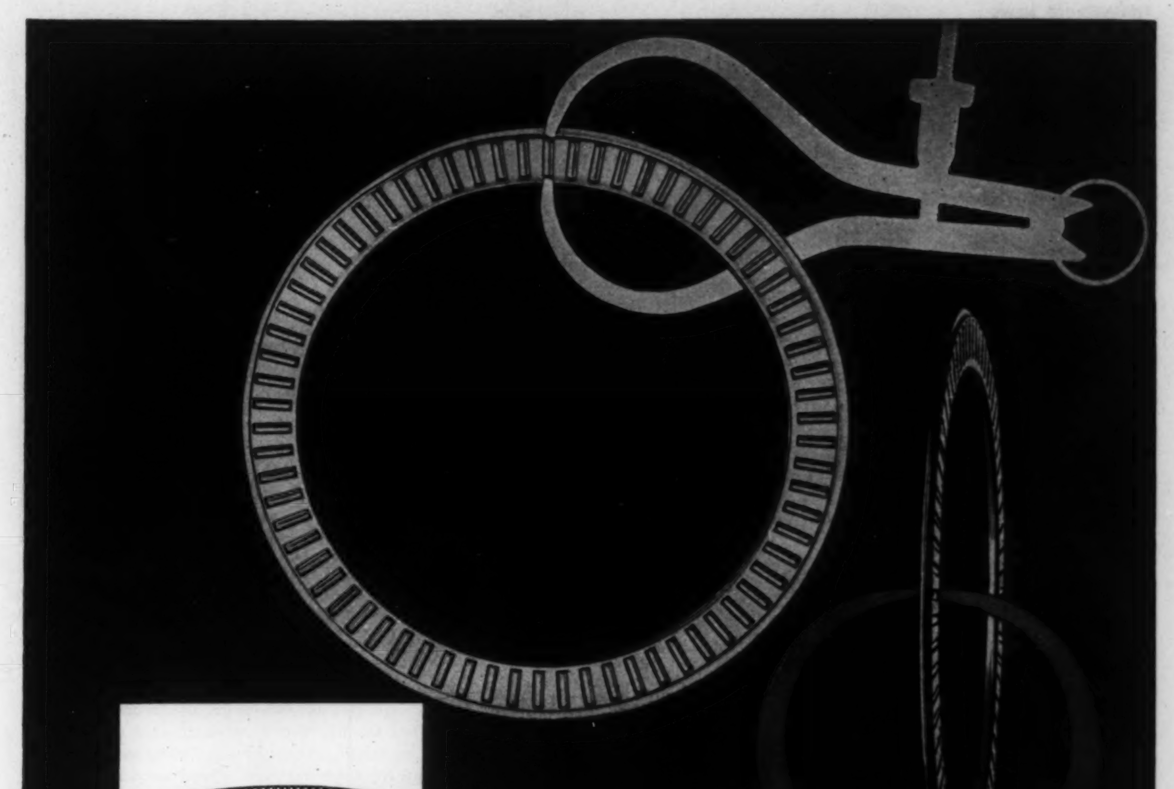
Defense Digest

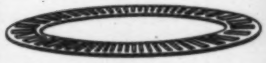
Alert Pods for the B-70 . . . will be designed around 960-hp Lycoming T53 turbine engine. Pods, also known as ground-power units, will furnish continuous power to the Mach-3 bombers while they remain on stand-by, and supply the extra power needed to start engines. Beech Aircraft Corp. will build the units under an $8 million Air Force contract.

More Range for the B-52 . . . is promised when seventy of the big SAC bombers are equipped with Pratt & Whitney's new turbofan engine. Designed around P&W's J-57, the turbofan powerplant handles about 2.5 per cent more air, gives almost 50 per cent more takeoff thrust, and cuts specific fuel consumption at cruise by approximately 13 per cent. Range increase for the B-52 will amount to some 500 mi. More than 90 per cent of J-57's original parts are utilized in the turbofan version. Primary changes in transition were in the first three compressor stages, where two fan stages were added. Fan blades are half again as long as other compressor blades in the engine and supply about 50 per cent of the turbofan's thrust. Rework of the engines can be done at Air Force Bases, without return to the factory.

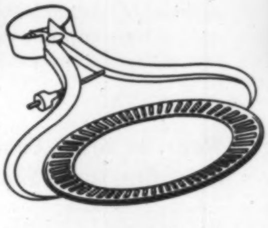
BMEWS plus DEW . . . will give U. S. a minimum warning of 15 min in event of enemy ballistic missile attack. Three huge BMEWS (Ballistic Missile Early Warning System) installations are under construction in Alaska, Greenland, and in one undisclosed location, with total cost estimated at well over $1 billion. RCA is prime contractor. Each BMEWS site has a reach of 3000 mi, uses antennas the size of a football field, and needs more electrical power than a small city. The system will tie into the now operational Distant Early Warning Line (DEW).

First Ballistic-Missile Submarine... *George Washington*, will be launched June 9, at General Dynamic's Electric Boat Div., Groton, Conn. The 380-ft nuclear-powered vessel has vertical tubes for firing solid-fueled Polaris missiles from on or below surface, and is also equipped with the conventional torpedo-firing system. Scheduled to become operational in 1960, *GW* displaces 5400 tons (surfaced) versus 3200 tons for *Nautilus*.

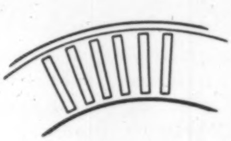




It's .0781" THIN! . . . to meet the most restricted space needs.



OD is much smaller, for given shaft size, than other types of thrust bearings.



Needle-proportioned rollers provide large contact area in minimum cross section.

By Every Measure . . . Ideal For Compact Thrust Applications

Whether you gauge its value in compactness, high anti-friction efficiency, high thrust capacity, or low unit cost, you will find the new Torrington Needle Thrust Bearing measures up ideally to your needs.

This needle-type bearing is designed specifically for thrust loads in restricted space. It may run directly on adjacent hardened and ground surfaces or on standard thrust races. Used alone, or in combination with Torrington radial type Needle Bearings, the Needle Thrust Bearing finds wide use in many applications including steering gears, hydraulic pumps, tractor bolsters, bevel and worm gear boxes, governors, outboard motors, 2-cycle engines, washing machines, power tools, torque converters, and automatic transmissions.

For engineering information and assistance in design, please call upon the services of Torrington's Engineering Department. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

Visit Torrington • Design Engineering Show • Philadelphia • May 25-28

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS • THRUST

Molectronics Starts Fast: Crystal Grown to Finished Form

WASHINGTON—With the announcement of a $2 million contract awarded Westinghouse Electric Corp., the Air Force has initiated the science of "molecular electronics." The ARDC contract is part of a broad program with three objectives:

- Design of equipment with inherent dependability and life sufficient to do a space-age job.
- Reduction of the number of thermal energy consumers in electronic systems.
- Increase (by several orders of magnitude) of electronic functions performed per unit volume.

The first contract recognizes a revolutionary technique for growing germanium crystals developed by Westinghouse. Crystals can be grown to the exact form in which they will be used in transistors, etc. The technique leads to a basic new concept in electronic-systems design. It deals with dimensions of molecular size. In use, very small pieces of crystals could perform functions that now require many components using conventional circuitry. The new technique may lead to equipment 1000 times smaller and lighter than anything in existence.

Thin, highly polished ribbons of germanium are grown by a new technique. A radical departure from conventional methods, Westinghouse calls it the first major breakthrough in preparation of germanium and other semiconductor materials since their commercial introduction. Germanium strips are produced in the exact form used in transistors and other semiconductor devices. No costly time-consuming cutting and grinding are required. Previously, grinding would waste up to 80 per cent of conventional ingots of germanium. The method will eventually make possible the manufacture of transistors and other devices by automatic machine and will reduce processing expense.

One application of molecular electronics has been demonstrated. Until now, the most modern system to measure light intensity in space has a volume of about 1 cu in., and weight of about 7 grams. A telemetry subsystem based on the new concept weighs 0.02 gram and has a volume of 0.001 cu in. It not only measures light intensity changes, but also produces a signal capable of transmission. The subsystem has only one part and only two soldered connections.

Design Engineering Show—May 25-28
Convention Hall—Philadelphia

DESIGN ENGINEERING Show AND CONFERENCE

MACHINE DESIGN's annual guide to the Design Engineering Show starts on page 199 of this issue. It's a packed preview of what promises to be one of the biggest and best industrial expositions of 1959. When you finish the pictorial tour, make plans to see the real thing—all the details are in the Show Guide.

Want an Army Contract? Here Are Some Shortcuts

WASHINGTON—Help is available for the small businessman who is lost in the red-tape of Army contracts. A wealth of newly updated information and guidance is available. To get it, whether interested as a prime contractor, subcontractor, or supplier, all you have to do is ask. Available from one source (Office of the Army Small Business Advisor, The Pentagon, Washington 25), the packet highlights:

- List of the Army's small business advisors, both by geographical location and by Army department.
- Copy of the "Small Business Act of 1958," Public Law 536.
- Booklet of consolidated Defense Dept. and Army Dept. small-busi-

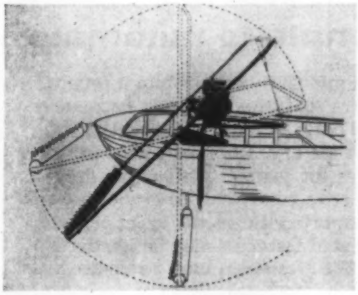
ness policies, programs, and procedures.

- Booklet titled "How to Sell to Agencies within the Dept. of Defense."
- "Contractors Guide" to assist the contractor in properly making out and filing a contract proposal.

The information should result in much less confusion for all concerned.

Bearings by the Spoonful

Miniature bearings as small as 0.050 in. OD can be produced on a new centerless internal grinding machine developed specifically for miniature work. The machine also grinds bearing races to 0.00015 in. tolerance and 5-mu in. finish. Developed by the Heald Machine Co., Worcester, Mass., the machine automatically maintains precise wheel-to-diamond relationships and compensates for drift. It won the first Miniaturization Award ever presented for a machine tool.



Mower Cuts Aquatic Lawn

Boat-mounted sickle-bar mower controls underwater plants in harbors, channels, and swimming areas. With the mower mounted on the gunwale of any outboard-powered rowboat, the cutting bar clips plants 30 to 36 in. underwater. The mower is driven by its own 2¾-hp engine. Developers, Jari Products, Inc., Minneapolis, Minn., recommend a moderate trolling speed for maximum efficiency.

900° F. STOCK BEARINGS

PERMIT RAPID SOLUTIONS TO HIGH-TEMP PROBLEMS

TYPE: Deep groove radial.
SIZES: 200, 202, 204 and 206.
BALLS AND RACES: High speed steel.
RETAINERS: Machined, land riding.
ACCURACY: ABEC-5.
LUBRICATION: None.

THESE NEW ITI ball bearings are for use at elevated temperatures up to 900° F. At such temperatures, their load capacity is greater than any other bearings of like size, and they have unusual dimensional stability. They open new horizons in developmental work, because (1) they provide a first approximation to the solution of a wide range of high-temperature bearing problems; (2) they're *available from stock;* and (3) they *cost far less* than custom-made experimental bearings.

You can see these bearings at **BOOTH 504,** Design Engineering Show; and our top technical men will be on hand to discuss application problems. We're also exhibiting custom-engineered bearings for special requirements, precision balls, modified balls, and other spherical products.

If you won't be at the Show, write for literature on 900° bearing and other items of interest.

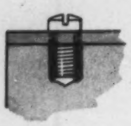
INDUSTRIAL TECTONICS, Inc.
ITI
MANUFACTURERS OF PRECISION BALLS AND BEARINGS
3699 JACKSON RD., ANN ARBOR, MICH.
WESTERN DIVISION PLANT: COMPTON, CALIFORNIA

Circle 411 on Page 19

THE LIQUID LOCK FOR METAL PARTS

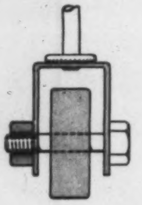
. . . improves fastener reliability and reduces costs!

Loctite sealant makes ordinary fasteners into lock fasteners at savings of 40%-70%. Locking action extends over the entire engaged area providing unequalled resistance to vibration . . . ends breakdowns due to loosening of fasteners. A single drop of **Loctite** replaces all sizes of lock nuts, lock washers, lock screws, jam nuts, staking and interference threads.



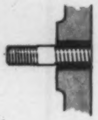
- ELIMINATES LOCK WASHER OR SELF-LOCKING SCREW

Makes ordinary screws into lock screws. Several times the holding power at savings of $20/M.



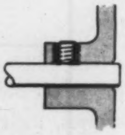
- ELIMINATES SELF-LOCKING NUT OR JAM NUT

Locks non-seated nuts anywhere along the length of thread.



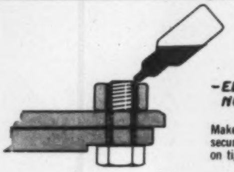
- ELIMINATES INTERFERENCE FIT

Locks studs securely . . . locking action develops after stud is in place . . . allows easy-driving Class 2 threads. End stripped threads, broken studs, damaged castings.



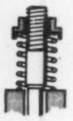
- ELIMINATES DOUBLE SET SCREWS, SELF-LOCKING SET SCREWS, JAM NUTS ON EXTENDED SET SCREWS OR STAKING

LOCTITE-treated set screws cannot vibrate loose . . . end nuisance service calls.



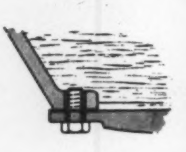
- ELIMINATES SELF-LOCKING NUT OR LOCK WASHER

Makes any nut a lock nut. Saves 40%-70%. Holds securely where lockwashers fail. Does not depend on tightening torque for locking action.



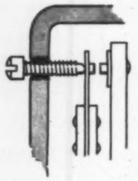
- ELIMINATES SPECIALS OR STAKING

Makes any threaded part self-locking.



- ELIMINATES BLIND HOLE TAPPING, SPECIAL LEAK-PROOF FASTENERS

LOCTITE locks and seals threaded parts against vibration and high-pressure fluids.



- ELIMINATES SELF-LOCKING SCREW OR JAM NUT

Get the right setting the first try . . . no backlash. LOCTITE provides the proper amount of drag to hold adjustment securely. Permits repeated adjustments.

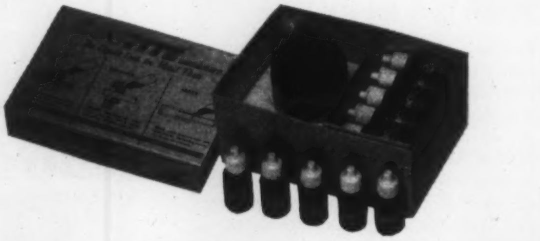
LOCTITE Sealant is easy to apply . . . simple to automate

Labor savings are obtained when several days supply of threaded parts are treated by tumbling with **Loctite** Sealant. Treated parts store for days, lock only when assembled. Smaller quantities may be tumbled by hand in polyethylene bags. Parts may be individually treated using applicator nozzle on **Loctite** bottle or by using continuous feed tube. Parts may be treated *after* assembly, **Loctite** wicks into threads by capillary action.

Loctite is a thin liquid that hardens into a tough heat and oil-resistant seal when confined between closely fitting metal parts. It requires no heating or mixing . . . does not air dry. **Loctite** comes fully prepared . . . stores for years . . . hardens only when treated parts are assembled. Ten grades provide any desired torque to all sizes and types of fasteners. **Loctite**-treated fasteners may be removed with ordinary tools . . . fasteners may be re-used.

LOCTITE Kit No. 10-10

Contains 10 grades of Loctite sealant specially put up to assist engineers in determining proper grade of Loctite in product development and for general experimental work. By selection of proper grade, the designer can apply a pre-determined amount of locking torque.



Write for literature and free sample.

LOCTITE® SEALANT

AMERICAN SEALANTS COMPANY • 111 WOODBINE ST., HARTFORD 6, CONN.

Reader Information Service

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EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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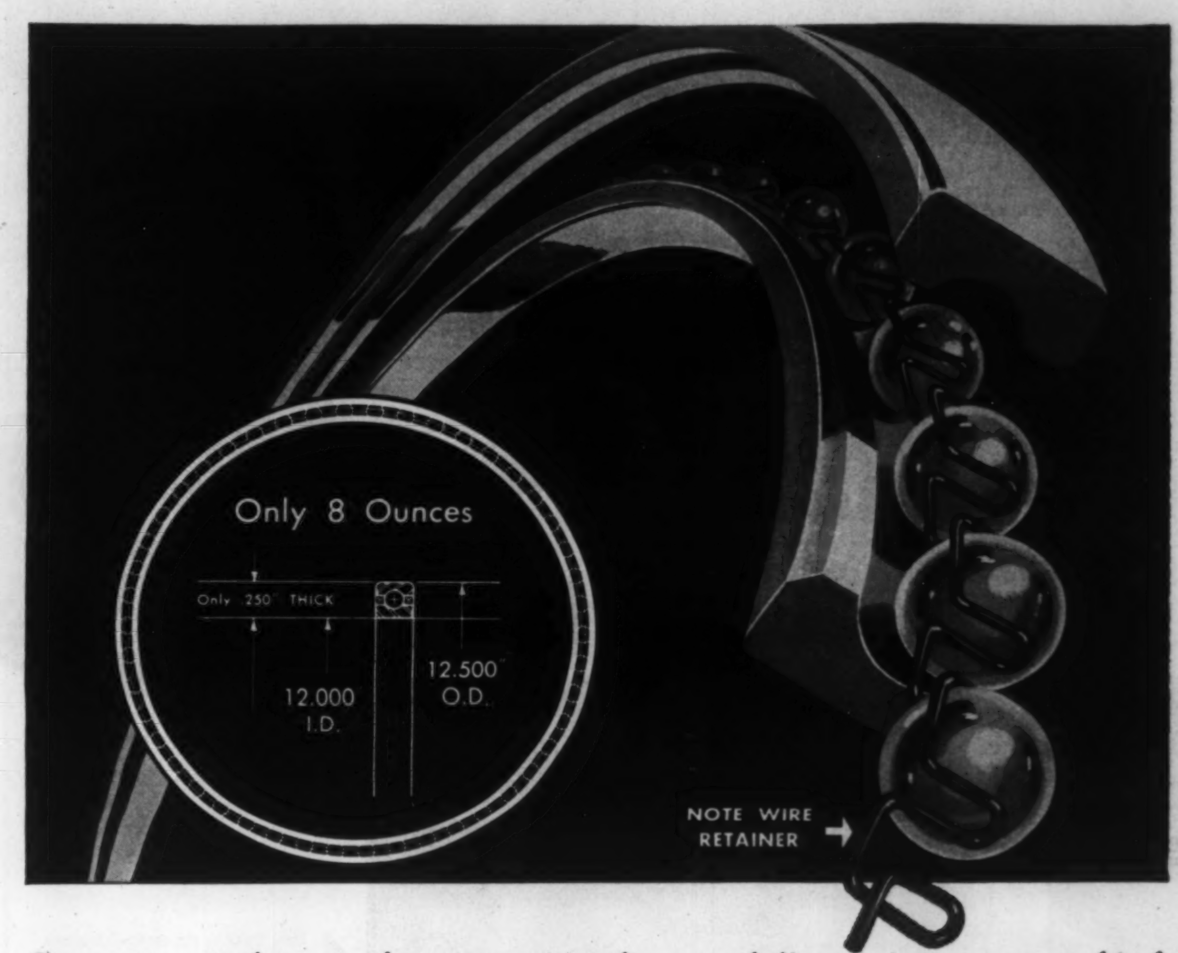


Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

. . . now carried in stock in 4" to 12" bores

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

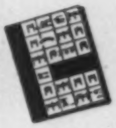
The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".



THE KAYDON ENGINEERING CORP.

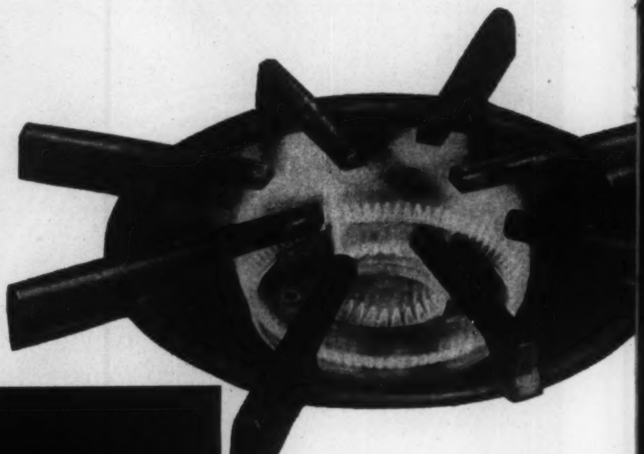
MUSKEGON • MICHIGAN

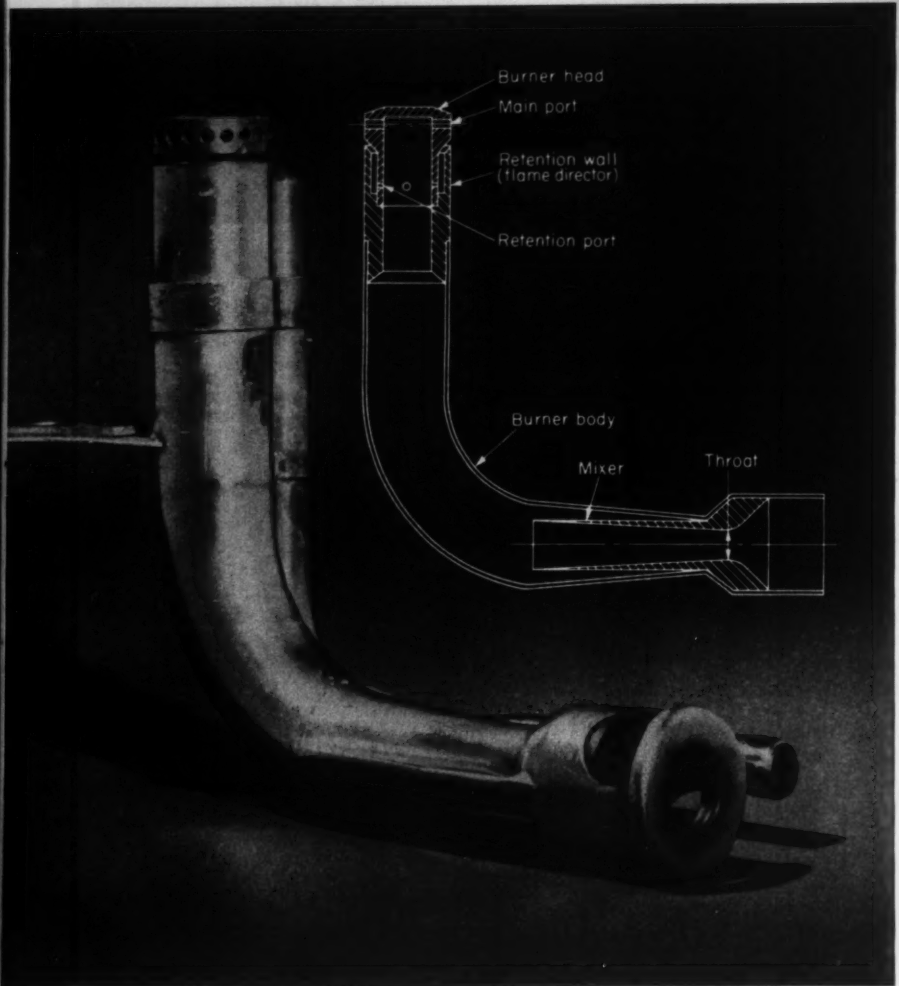
K-561R

All types of ball and roller bearings — 4" bore to 178" outside diameter . . .
Taper Roller • Roller Thrust • Roller Radial • Needle Roller • Ball Radial • Ball Thrust Bearings

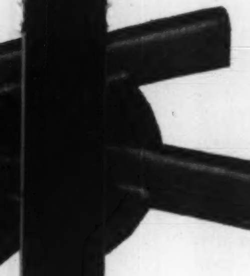
Keeping a gas flame where it belongs—on the ports—is tough with high inputs and small burners. AGA researchers have found a new way to make the flame behave. They're "building a fire under the flame" to produce . . .

High-Speed Gas Burners




Burner head
Main port
Retention wall (flame director)
Retention port
Burner body
Mixer
Throat

The "nickel diameter" burner, though much smaller than conventional kitchen-range burners, is designed for the same input rate. Fuel gas entering the mixer is diluted by entrained air. The air-gas mixture discharges at high velocity through both main and retention ports. The retention wall slows and spreads retention mixture so that it burns with a soft halo just below the main ports. While high discharge velocity through the main ports would normally cause flames to blow off, the halo constantly re-ignites the main flame.



The AGA Story

The American Gas Association is a nonprofit trade association of gas utilities. Combining in support of one central agency, these utilities do a job none could do alone. The AGA is best known for its testing and American Standard programs that maintain rigid safety and performance standards for gas appliances. Other lesser known AGA jobs include directing gas promotional activities through national advertising campaigns and sponsoring research. Research is directed by AGA committees made up of utility and manufacturer delegates who are in close touch with the public. Research is consequently both practical and timely. While detailed design of prototypes is sometimes necessary, the object of AGA research is to uncover basic principles. Research results are sent to manufacturers in published report form. Further information can be obtained by contacting the American Gas Association, 420 Lexington Ave., New York.

BURNERS the size of a nickel may soon give gas appliances a new look. Developed at American Gas Association's Cleveland Laboratories, hot new "flame-retention" burners are outperforming every other type of atmospheric burner. Intended for a wide range of applications, some models are already in production.

According to W. B. Kirk, AGA's chief research engineer: "Research by AGA on consumer appliances and burners is 10 years ahead of production. Careful planning by AGA research committees keeps it this far ahead. With access to the combined experiences of gas utilities and appliance makers, these committees accurately foresee future consumer demands.

"First conceived about 10 years ago, flame-retention burners have now been developed by AGA to such a degree that they are literally forcing their way into the market. They are already offered in the restaurant cooking-appliance line of one manufacturer, and in a kitchen-range line of another."

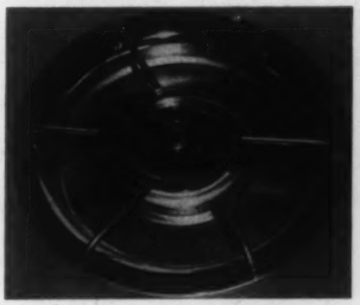
What's It All About?

The flame-retention burner differs from conventional atmospheric burners in that a set of special-purpose ports is added to the burner head. These ports, called retention ports, are combined with a flame director which aims retention flames at a point just below the lower edges of the main-burner ports. Even with very high gas-jet velocity through the main ports, the main flame cannot blow out. In effect, retention ports provide constant-burning re-ignition.

Flame-retention burners have three chief advantages:

- High input rates.
- Improved combustion efficiency.
- Wide span of operating rates.

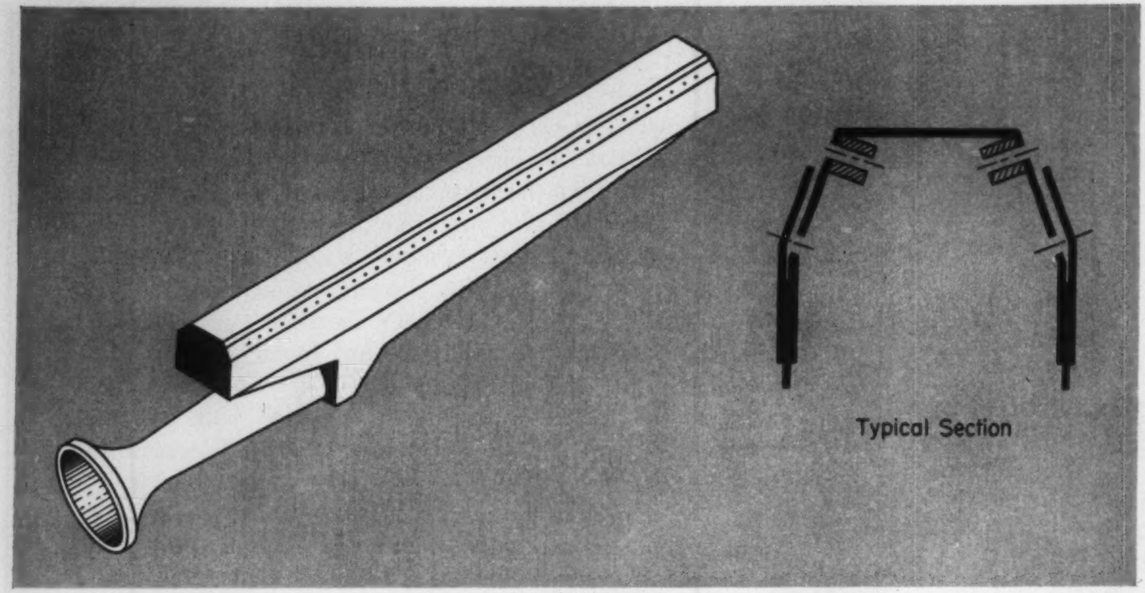
All three advantages are due to the ability of flame-retention to make gas flames behave. Atmospheric gas burners have long been designed around three undesirable flame tendencies, all of which can now be better controlled. Chief problems tamed by the retention burner are: 1. Blow off. 2. Flash back. 3. Extinction noise.



Mounted in a kitchen range top, the "nickel diameter" burner is dwarfed by the grate. The heat-resistant glass disc spreads flames to reduce hot spots on the utensil bottom.

Tricky Old Problems

Output of a conventional burner is limited by the amount of gas



Flexibility of flame-retention design is illustrated by this bar burner. It handles 40,000 Btu per hr—about double conventional bar-burner input. Used in combustion chambers where little air is available, the bar burner entrains 70 per cent combustion air at the mixer. Constant pressure throughout the head is obtained by sloping the burner bottom.

that can be pushed through the burner ports. If the jet travels faster than flame-propagation velocity, the flame blows off and either extinguishes, or settles in the open air. Increased port diameter does not solve the problem of high input rate design. A flame has greater tendency to flash back (through the burner head to the gas-supply orifice) with larger diameter ports.

Combustible air-gas mixtures are sometimes present as transients in the burner head. They occur even in well-designed burners when a change in valve-setting is made; i.e., when the burner is first turned on, off, or way down. Flash-back tendencies are especially strong when the burner is turned down, and noisy extinction (flash back on extinction) tendencies are strong when the burner is quickly turned off after long operation at full rate.

One conventional way to restrain flash back is to design for limited atmospheric-air injection. With resulting rich burner-head mixtures, the mixture is not combustible, even during transient periods.

The New Answer

With the flame-retention burner, input rate per port can be increased to several times normal value. High-temperature, high-speed burners with tractable behavior can be designed. If, however, input must be restricted, port sizes can be made quite small without danger of blow off.

Flash-back tendencies, reduced by small ports in any burner, are further reduced by a time-delay effect brought about by high jet velocities. Flash back cannot occur unless jet velocity is less than flame-propagation velocity. Even with a rapid decrease of valve setting, jet velocity does not change as fast as air-mixture concentration. When the mixture is combustible, high jet velocity restrains flash back, and when jet velocity has decreased, the head mixture is no longer combustible.

With flash back safely controlled, air percentage in the head mixture can be made quite high. This has two advantages: 1. Because of improved air-gas mixing, combustion efficiency is increased. 2. Because of the leaner head mixture, less air need be supplied at the ports for combustion. Burners in which all combustion air is pre-mixed are now practical and have been demonstrated in the laboratory.

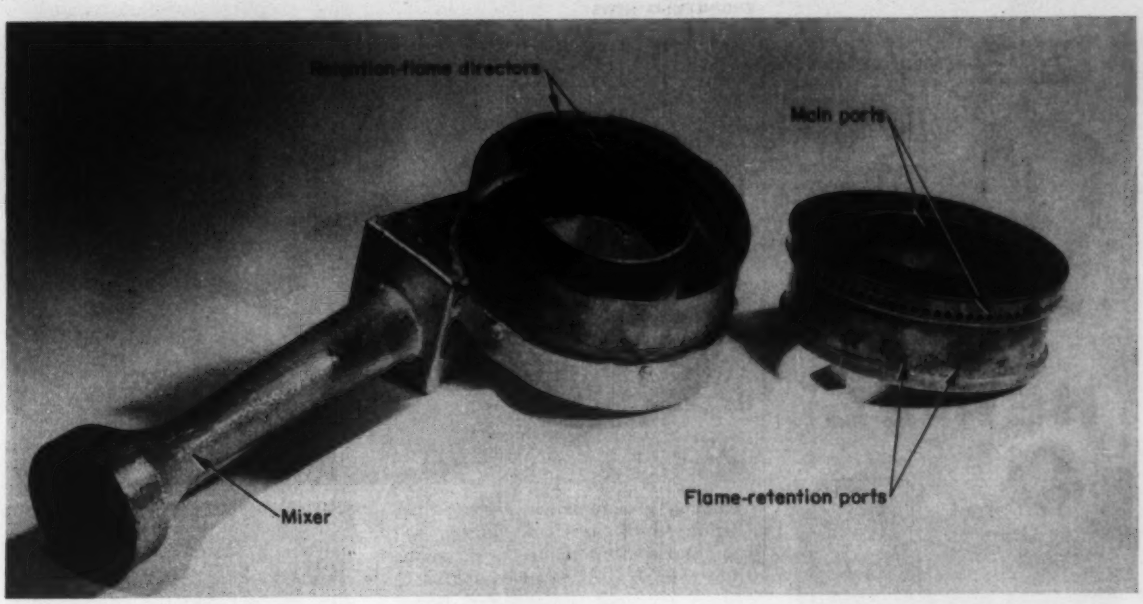
When input rate, port diameter, and pre-mixed air concentration are properly combined, minimum input rate can be matched to the application. While design for both very high and very low inputs is not possible in the same burner, a wider operating span is available with the flame-retention burner than with any other burner employing a single gas supply orifice system.

Mixers Set the Limit

Whether designed for high input, high combustion efficiency, or low turndown, the flame-retention burner is designed for lean head mixtures. This assures sufficient combustion air at high inputs. At lower inputs, the lean-mixture combustion efficiency is desirable. The major limitation to the flame-retention burner performance is obtaining sufficient air injection.

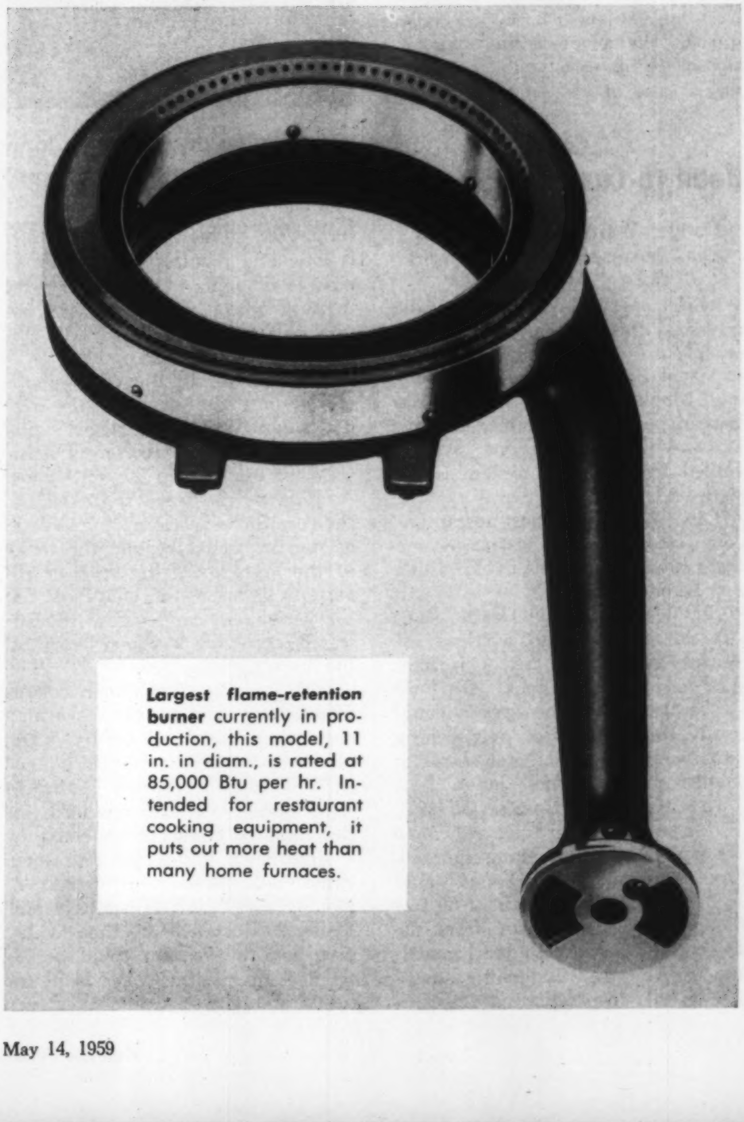
Air injection is determined by mixer-tube design. Mixer throat area, total port area, mixer length, venturi slope, and orifice position all have their effects on air injection. As part of the AGA flame-retention burner program, interrelations between these variables were precisely determined.

An atmospheric burner can be designed for any desired amount of air injection as long as size limitations are not imposed on the mixer-tube. Limitations to flame-



▲

This circular flame-retention burner and the bar burner are now in production. With the burner head lifted out for cleaning, retention ports are exposed. The few retention ports require little of the 25,000 Btu per hr rated input. Conventional burners designed for the same application are rated at 15,000 Btu per hr.



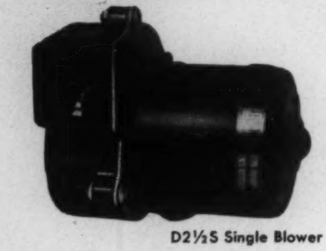
Largest flame-retention burner currently in production, this model, 11 in. in diam., is rated at 85,000 Btu per hr. Intended for restaurant cooking equipment, it puts out more heat than many home furnaces.

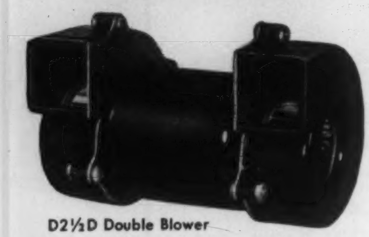
retention burner performance are therefore almost entirely due to space limitations dictated by the various gas-burner applications.

For example, the optimum ratio of throat area to total port area was established as 0.45. With either higher or lower ratios, less air is entrained at the mixer face. Where available space limits mixer size, however, the ratio could fall to as low as 0.30 without resulting in a serious decrease of entrained air.

What's Next?

Although new, the flame-retention burner may be headed for early obsolescence. According to AGA's Kirk: "The future in gas appliance design can only be described as unlimited. Projects concerning flameless combustion (catalytic burners) and very-high temperature, infrared-producing gas appliances are now active at AGA and other laboratories. These and similar projects are already influencing the future appearance of gas appliances."—R. A. Jacobson.





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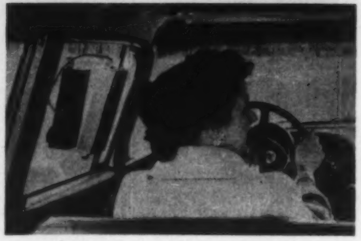
GM
INFORMATION
TRANSMITTER



Warning or information message being taped by patrolman, above, will be inserted in transmitter for automatic broadcasting to passing motorists. Ferrite antennas are mounted beside the highway. Transmitters using wire-loop antennas could be buried underground. Portable receiver, right, designed for toll-road rental, hangs on the window at the left of the driver.

Road-to-Car Radio System May Make Motoring Safer

Danger Warnings, Reprimands On "Person-to-Person" Network

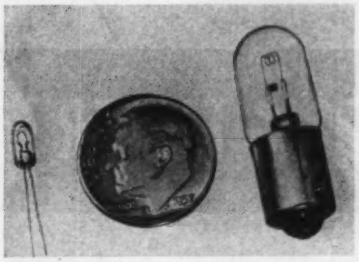
WARREN, MICH.—Working on the premise that drivers react more quickly to the spoken word than to visual signals, engineers at General Motors Research Laboratories have developed a reliable, effective highway communications system. Called Hy-Com, the system is designed to:

- Give motorists almost instantaneous trouble-ahead warnings and assist highway officials in expediting and rerouting traffic.
- Supplement roadside traffic signs that the motorist might overlook, especially at night, in fog, or in other poor-visibility conditions. On busy city expressways, the system could notify the motorist of approaching exit ramps in time for him to maneuver into turnoff lanes.

In a typical Hy-Com installation, two transmitters are located in a waterproof enclosure along the road. One sends out a continuous signal from a loop extending about 50 feet along the road upstream from the transmitter. This length of road is the trigger zone. Extending downstream is a loop radiating voice information. This zone is about 500 ft long and requires about 6 sec to pass at 65 mph. It allows a 3-sec message to be repeated twice before a car is out of range, which is considered adequate.

The receiver in the car is inoperative until the car enters the trigger zone. When the trigger signal is picked up, the receiver is sensitized for listening to the voice zone. As long as the voice is picked up, the receiver is held on, but as soon as the car passes beyond the range of the voice loop, the receiver reverts to its insensitive condition. On the permanent car receiver, the auto radio program is also switched off by the triggering signal.

GM says the new system can be modified to send a verbal warning only when the speed limit is being exceeded. Its message can be changed at will from a central control if telephone lines are provided, or the message could be switched by a time clock if desired. Patrolmen could talk directly to drivers of moving cars from transmitters permanently installed in their squad cars, and the system could be altered in many other ways to fit the needs of highway traffic engineers.



A Billion Years—That's Life!

The tiny lamp to the left of the coin was built to have a continuous operating life of a billion years. Used in airplane instrument panels, the light is designed to withstand vibrations and voltage surges of a high order. At the other end of the service-life scale, the larger lamp, right, is designed to give an intense light for only 15 sec. Chicago Miniature Lamp Works built it as a light source for tracking the early flight of missiles. Light fails when lamp heat melts the glass bulb.

High-Frequency Inverter Promises Bright Future

NEW YORK — Electroluminescent lighting has taken a long jump toward practicality for home use, thanks to a new high-frequency static inverter. The inverter, developed by Magnetic Amplifiers Inc., converts both battery current and 60-cycle ac to frequencies ranging from 2000 to 10,000 cps.

Essentially, EL lamps consist of flat panels of glass with an electrically conductive film, plus a phosphor coating which emits light when excited. Brightness levels of these lamps have, in the past, proved low. While brightness increased with both voltage and frequency of the excitation signal, lamp life was short when high voltages were applied, and high-frequency equipment was bulky and cumbersome.

The new inverter has changed this. Illumination level is increased ten fold, and lamps have an almost unlimited life expectancy.

Electroluminescence furnishes a glareless, evenly spread light similar to that which comes from the sky. Free from the traditional glass envelope, it is especially desirable for visual display and home-lighting applications.

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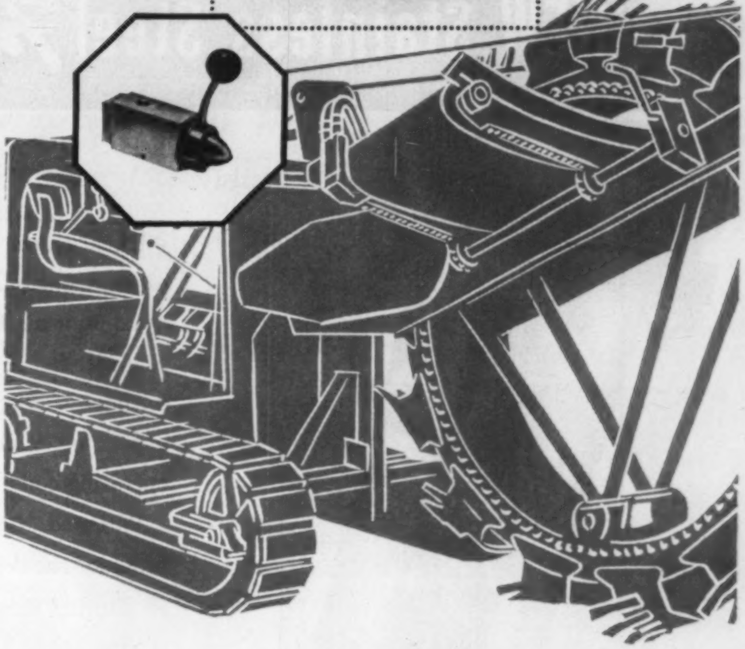
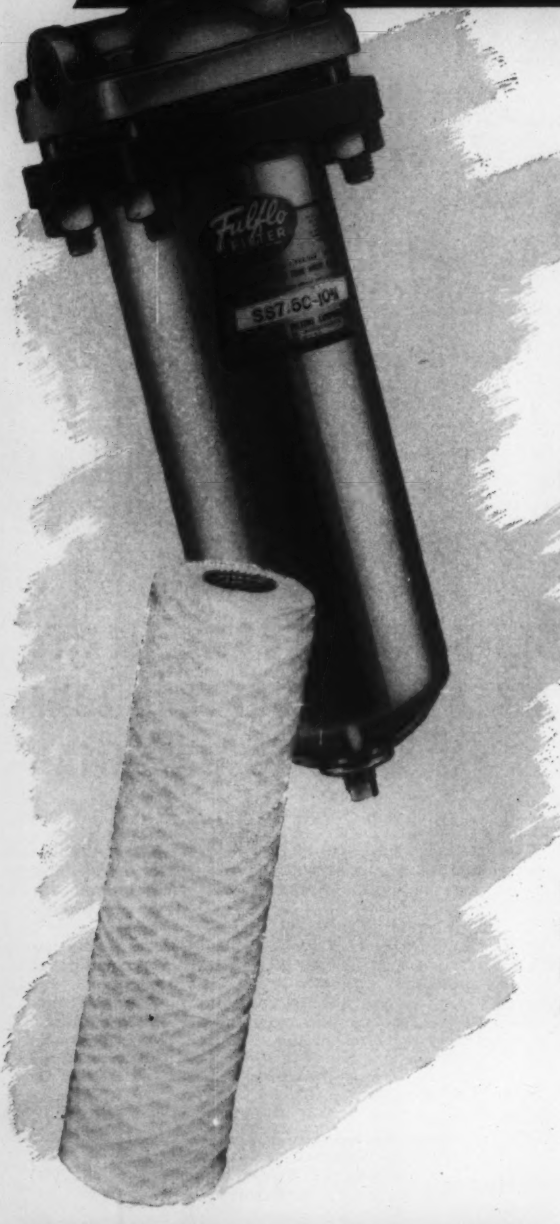


FOR PRESSURES UP TO 750 psig . . . . .

NEW Stainless Steel Fulflo FILTER



This rugged, compact filter is ideal for high pressure pneumatic and hydraulic applications. Maximum air flow rate is 650 SCFM at 750 psig with initial pressure loss of 3 psi. Flow rate for liquids of aqueous viscosity is up to 5 gpm, depending on nature of fluid, contaminant and operating conditions.

Patented 10-inch Honeycomb Filter Tubes provide true *depth* filtration through hundreds of filtering tunnels engineered for uniformity of size, shape and depth. Tubes are precision manufactured in a wide range of positively controlled densities to provide the exact degree of micro-clarity your operation requires — even down to 1 micron. Tubes are available in cotton, nylon, orlon, dynel, acetate and glass fibres.

Rugged one-piece shell is made from Type 316L stainless steel. All parts are of #316 stainless steel to minimize chemical reaction. Straight line pipe connections are ¾″ NPT. Overall filter size is only 13⁵⁄₁₆″ x 4⅜″.

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Circle 416 on Page 19

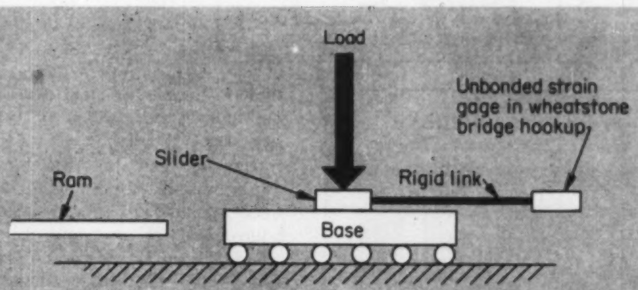
Friction Fiction?

T F *Static friction exceeds kinetic friction.*

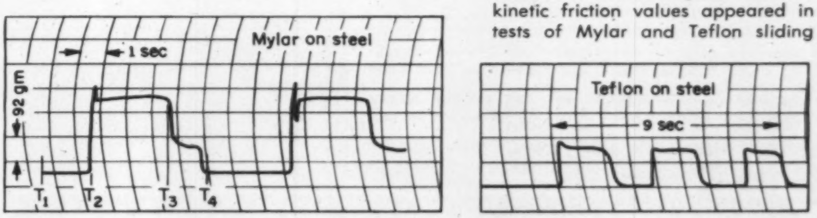
T F *Lubrication reduces slow-sliding friction.*

T F *Light oil causes less friction than grease.*

T. R. KNOWLES
Senior Mechanical Engineer
Nortronics, Div. of Northrop Corp.
Hawthorne, Calif.



Friction samples tested were steel, Meehanite, brass, Teflon, and Mylar. Base pieces were hardened 52100 steel. One had an electrolized surface of 2½ to 3½ mu in. surface roughness. The other had a ground surface with a roughness of 2 to 4 mu in. with the lay of the grinding, and 13 to 17 mu in. across the lay. Test results showed little choice between surfaces or lay of the grinding. Lubricants tested were oils, graphite, molybdenum disulfide, and silicone grease. Sliding rates were 0.3 to 4.5 in. per min. Heavy ram, small travel of sensing arm (0.002 in.), and slow sliding rates minimized effects of acceleration.



Traditional relationship of static and kinetic friction values appeared in tests of Mylar and Teflon sliding on steel. Peaks at left ends of plateaus in force vs. time plots correspond to points of impending motion. Plateau height represents force needed to maintain uniform sliding motion. Ram contacted the base at T_2, reversed at T_3.

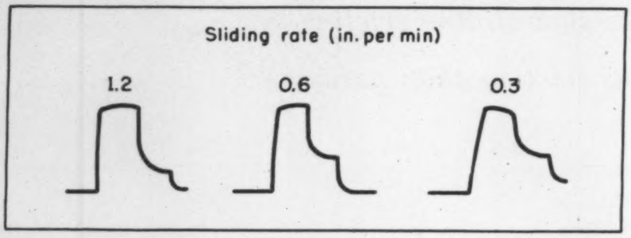
THE IMPRESSION, generally subscribed to, that static friction always exceeds kinetic friction apparently needs some qualification in the realm of smooth metal surfaces. In 1957, investigators at Marquette University found cases where kinetic friction was greater. Although this is contrary to most friction theories, accuracy checks of the system confirmed their conclusion.

Recent studies at Northrop's Nortronics Div., conducted with every practical safeguard for excluding external variables, provide further evidence that kinetic friction can exceed static friction. Tests conducted with brass on steel, Meehanite on steel, and steel on steel showed kinetic friction equal to or greater than static friction. Rubbing speeds were in the low range—from 0.3 to 4.0 in. per min.

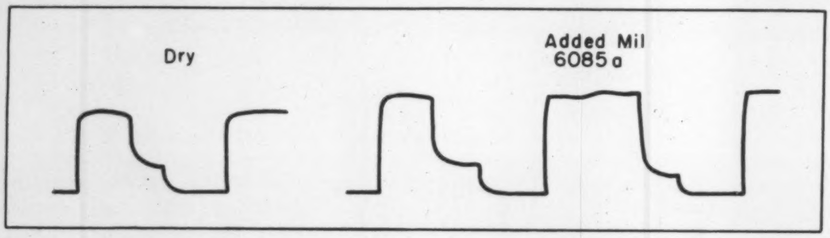
Traditional results where static friction exceeded kinetic friction were obtained for Mylar on steel and Teflon on steel.

Other unorthodox findings came from the experiments. For example, addition of dry lubricants or light machine oils to smooth metal surfaces was sometimes found to raise rather than lower the coefficient of slow sliding friction. Within limits of the tests, silicone grease gave far lower friction than other lubes.

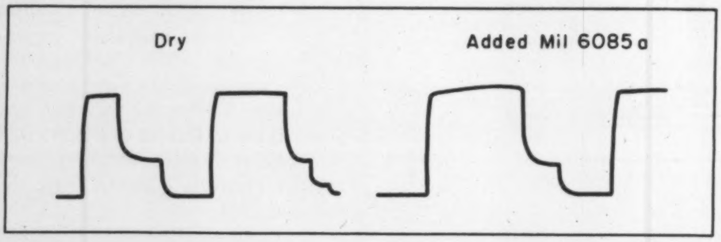
The accompanying sample graphs show the nature and extent of the more outstanding departures from tradition.



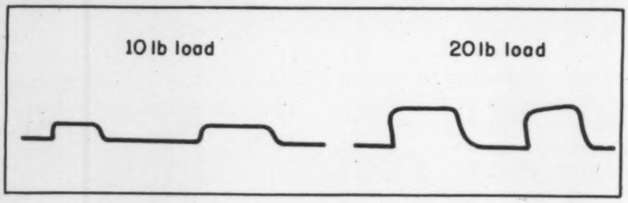
Meehanite-on-steel chart shows typical dry metal-to-metal friction pattern found in Northrop's tests. Positive slope of the curve at inception of motion shows buildup from starting force to a higher level for motion-sustaining force. Kinetic coefficient was 0.122.



Results for brass on steel show slightly positive slope at left of plateau. Note greater friction forces after oil was applied. Kinetic-friction coefficient was 0.116 dry, and 0.138 oiled.



Plateau in steel-on-steel chart is nearly square across the top. No significant change in forces of friction between static and moving conditions nor between dry and lubricated states is recorded. Equivalence of dry and lubricated friction is contrary to results noted for brass on steel. Static and kinetic coefficients were 0.139.



Performance of medium silicone grease (Mil 3278) as an antifriction lube is shown here. Normal load for trial recorded at left is 10 lb; at right, load is 20 lb. Coefficients of friction were found to be 0.011 and 0.012, respectively. For dry steel on steel, coefficient was about 0.14.

Summary of Tests

Sample	Load (lb)	Pressure (psi)	Lube	Friction Coefficients		Speed (in. per min)
				Static	Kinetic	
Mylar	3½	20	None	0.255	0.215	0.6
Teflon	5	160	None	9:8	0.046	0.6
Meehanite	5	50	None	0.114	0.122	1.2
Meehanite	5	50	None	0.114	0.122	0.6
Meehanite	5	50	None	0.114	0.122	0.3
Brass	5	150	None	0.108	0.116	0.6
Brass	5	150	Mil6085a	0.130	0.138	0.6
Steel	5	15	None	0.139	0.139	0.6
Steel	5	15	Mil6085a	0.139	0.139	0.6
Steel	10	30	Mil3278 (silicon added)	—	0.012	—

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H.P.	1/20 to 3000
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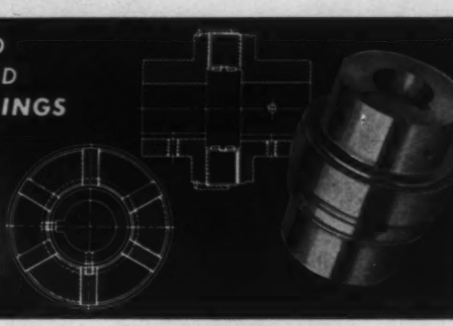

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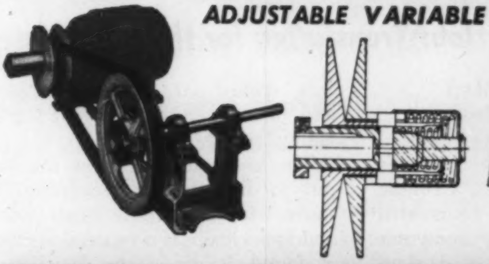

Bores (max.)	½" to 1⅜"
O.D.	3" to 13⅝"
Belt Sizes	A to 2⅜ TW
Speed Ratios	1-1 to 8-1
H.P. (1750 rpm.)	¼ to 18

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18 Models From Stock	
Speeds	8 to 425 R.P.M.
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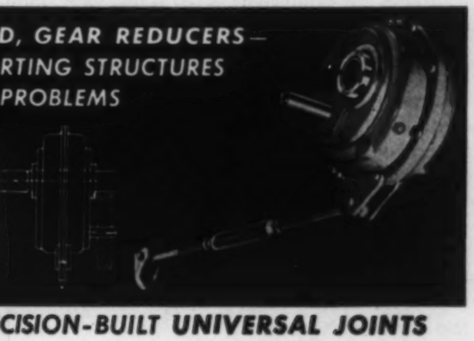
Hollow	Shafts 1 7/16 to 5 5/16 in.



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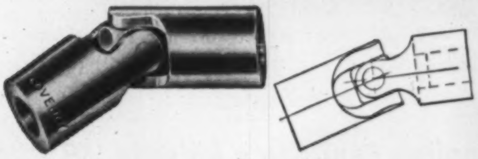

Bores	⅛" to 3"
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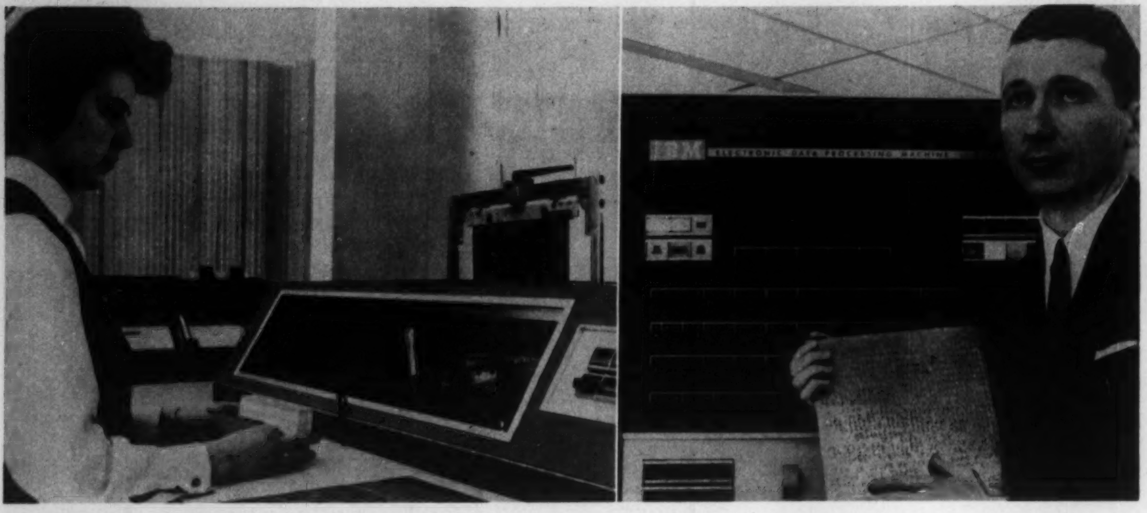


By eliminating the human translator, the IBM 704 data-processing system increases the literature available to the blind. Braille printing plate, right, is electronically produced by transcription of English text at the rate of 4000 wpm. The Braille embossing machine, left, directly produces the metal plates used to print Braille books.

Newest Computer Job: Translating for the Blind

Electronic "Table Lookup" Means More Braille Books

NEW YORK — Through computer translation of printed text, a Braille printing plate can now be created in minutes. Since the computer translates the equivalent of six days of human work in one hour, the serious shortage of qualified Braille translators can now be overcome. Translation of textbooks and technical material will help immensely in broadening career opportunities for the nation's 350,000 blind.

Developed for the standard and versatile IBM 704 data-processing system, the programming technique is that of "table lookup." Magnetic tape with Braille rules is stored in the computer's memory. The tape contains all contractions, abbreviations, and exceptions, as well as Braille alphabet and other standards, spelled-out in the same pattern of magnetic dots as the input signal.

The computer compares the input to the tape by scanning. It starts with the whole input word and looks it up. If no special symbol is found it drops the last letter and repeats the process until either a match is found, or the word has been cut back to the first letter. In the latter case, it prints the Braille version of this letter and starts over on the modified word consisting of the original word minus the first letter. In the former case, it prints the symbol for the matched group and the modified word consists of what is left over. The machine goes through hundreds of steps at electronic speeds to translate a single word. As many as 600 steps can be executed in less than 1/40 sec.

In translating a text, a typewriter with a conventional keyboard is first used to code punched cards. The cards are fed to the computer which prints a preliminary Braille-above-English text for editing. The text can be edited by operators who do not know Braille. After processing of the editorial corrections, a punched-card version of the Braille text controls the forming of embossed metal plates used for Braille printing.

Braille consists of 63 combinations of 6 raised dots. It includes alphabet, numerals, punctuation marks and 183 special contractions and abbreviations. Its symbols change meanings in different contexts, and its usage rules are complicated.

Developed by International Business Machines Corp., primarily for the American Printing House for the Blind, the program took one year to complete.

Student Salary Sampling Points to a Raise in '59

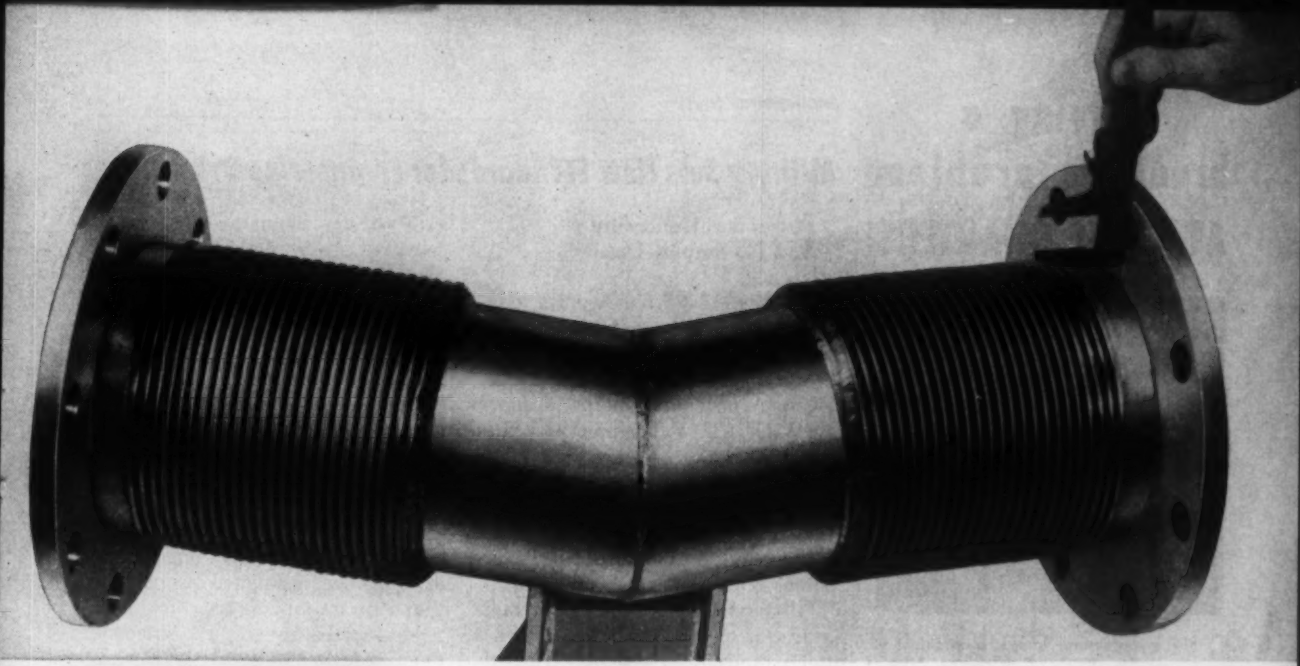
ANN ARBOR—The number of job offers to University of Michigan engineering students has increased and may go higher, reports Professor John G. Young, assistant to the dean of the College of Engineering.

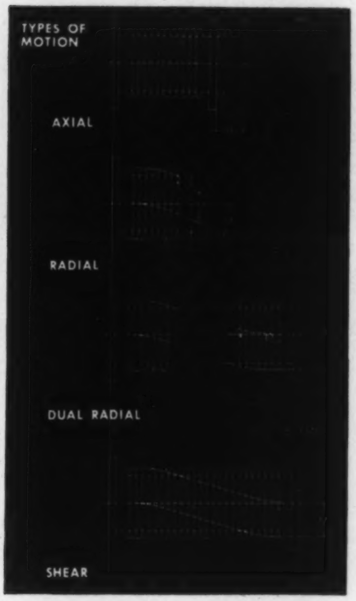
A sampling of the offers also indicates salaries are up about 5 per cent, with a Bachelor's degree pegged at about $505 per month, a Master's at about $600, and a Ph. D. at around $780.

A total of 556 known job offers to 352 students have been made during the present period, averaging about 1.7 offers per student. This compares with the 532 known offers during the previous year.

Since September 393 different companies have scheduled visits on campus. This compares with 494 last year. But the total number of visits has dropped only slightly, from 544 to 512.

Last year, Young explains, many companies scheduled visits early but cancelled when the recession developed. To date this year, 88 visits have been cancelled, compared to 184 a year ago.





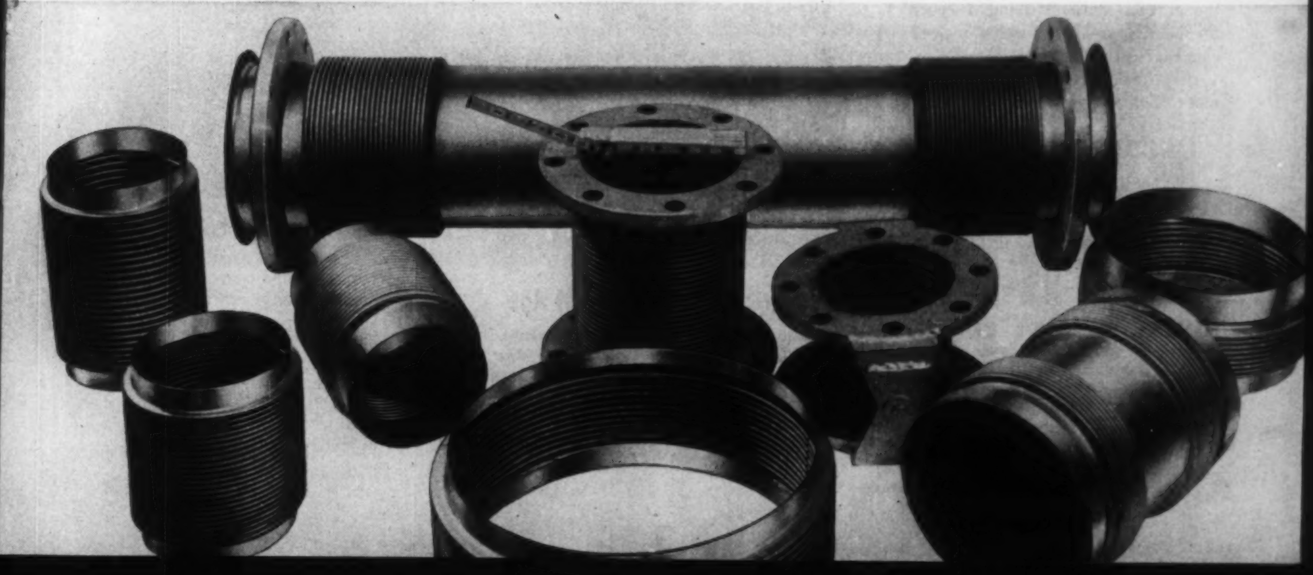
Expansion-joint tubing for big, tough jobs

New AX Tubing by Anaconda is available in Bronze, Stainless Steel, and other metals and alloys—from 4½" I.D. to 14" I.D.—to handle axial and lateral movement.

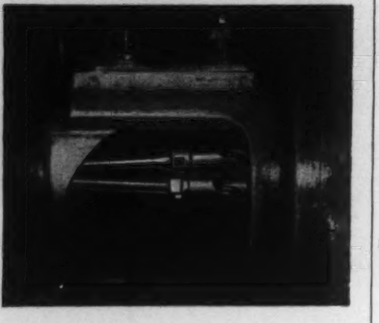
Need to compensate for contraction of piping suddenly cooled to minus 300°F by a large volume of liquefied gas? Want a bulkhead seal that "gives" with hull movement? Do you need a special assembly like that above, which handles an offset and a combination of lateral and axial movement? Wherever you need large diameter tubing to take care of movement shown in drawing at left, or simple offset, write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 59128

ANACONDA® METAL HOSE

Circle 418 on Page 19



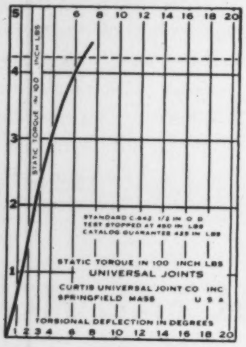
Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.

Torque Curve ½" Curtis Universal Joint



This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK –
⅜" to 4" O.D (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**
UNIVERSAL JOINT CO., INC.
5 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 419 on Page 19

Military Sets New Standards for Engineering Drawings

Strives for Uniformity And No Surplus Detail

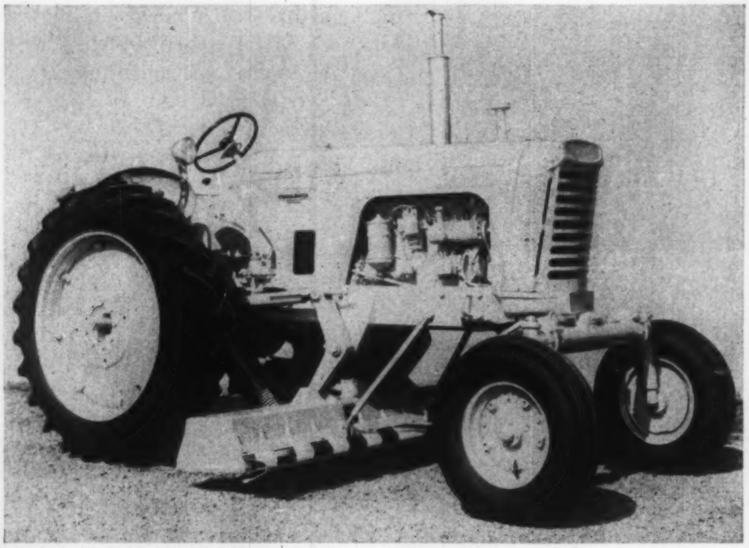
WASHINGTON—First move in a long range program to establish uniform specifications for engineering drawings has been made by the Defense Dept. A new uniform specification (MIL-D-70327) "defines for the first time the types of drawings that may be acquired by the military departments and is designed to assure that only the minimum amount of engineering detail, consistent with actual requirements, is procured."

All production contracts, as well as research and development contracts resulting in a design released for production, are covered by the new specification. Prime contractors and their subcontractors and vendors are affected by the specification.

Replacing, in whole or in part, 158 specifications formerly used by the military, the new standard also:

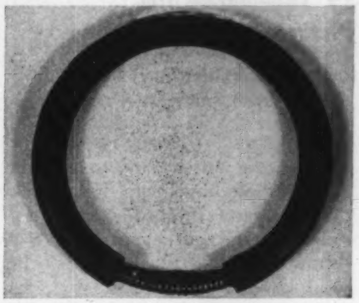
- Establishes uniform requirements for selection of drawing materials to assure satisfactory reproducibility.
- Sets up a standardized order of precedence for design identification of items, and establishes uniform requirements for identifying such things as inseparable assemblies and symmetrically opposite parts.
- Establishes minimum requirements for data to be placed on parts lists.
- Introduces a system of coding drawings to identify their source.
- Requires that proprietary or patent data which may appear on drawings be negotiated as part of the contract under the provisions of the Armed Services Procurement Regulation.
- Contains a check-off list for use by military procurement officers to assure that all requirements for drawings are properly identified in the contract.

Uniformity achieved with the new specification is expected to cut costs and increase efficiency in both industry and military drafting rooms by minimizing the number of details imposed on contractors.



Magnetic Butler for the Jet Age

Able to pick up a 500-lb steel plate, new magnetic sweeping equipment clears airport runways of ferrous debris that might damage jet engines. Designed by Consolidated Diesel Electric Corp., Stamford, Conn., a 5 ft long electromagnet is mounted under a four-wheeled tractor. Power for the magnet comes from a 5 kw, 120 v dc generator driven by the tractor engine. While sweeping, generator speed of 1750 rpm is maintained by an engine governor.



Spring-Cored O-Ring Seals

New type hydraulic seal, made up as a concentric spring within a hollow O-ring, is suitable for high temperatures and for applications where anti-extrusion devices formerly were needed and where Teflon back-ups are not suitable. Developed by Chance Vought Aircraft Inc., Dallas, the seals have been subjected to test and are now in production. Intended for high-temperature hydraulics and pneumatic application, they are also suitable as seals in a nuclear environment. Additional development work is continuing to increase temperature, pressure, and fatigue resistance.

Molder Sprays Unchopped Fiber

Designed for four simultaneous sprays, a new molding machine will handle continuous lengths of unchopped fiber. When fibers are not chopped to short lengths, strength of molded products is increased greatly, says Fiberlay Inc., Seattle, Wash. Other nozzles spray resins and solid aggregates so that an entire lamination need only be pressure-rolled for completion. Fire hazards due to volatile solvents encountered with some resins are eliminated since the machine is designed for operation on the plant air system.

Webster was right! Rectify means make right

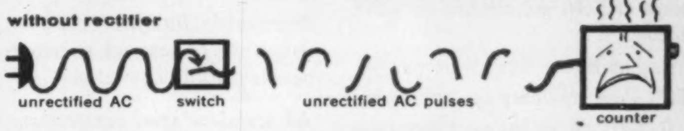
that's just what *built-in rectification* does for PIC Counters—*makes alternating current right* for efficient, reliable operation over a tremendous count life.

PIC-600 Electric Counter
50 million count life

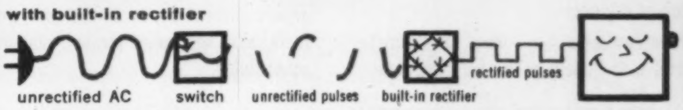
CE-800 Electric Counter
200 million count life

When operating PIC-600 or CE-800 Counters from AC you get the long recognized advantages of DC operation *without adding any circuitry or components.*

You can hear the difference. Ask your PIC Distributor or Representative for a demonstration or write us.



Pulses from unrectified AC vary greatly. The stronger pulses pound the counter, cause heating and fatigue; soon make the counter ready for the "final count". Excessive voltage increases destructive pounding and further reduces count life.



The rectifier converts the erratic AC pulses to uniform DC pulses. Pounding, noise and needless heating are avoided. AC hum is eliminated. Count life is more than doubled. The range of permissible excess voltage is widened.

PIC G C

Manufacturers of Counters, Switches, Relays, Actuators and Automatic Valves

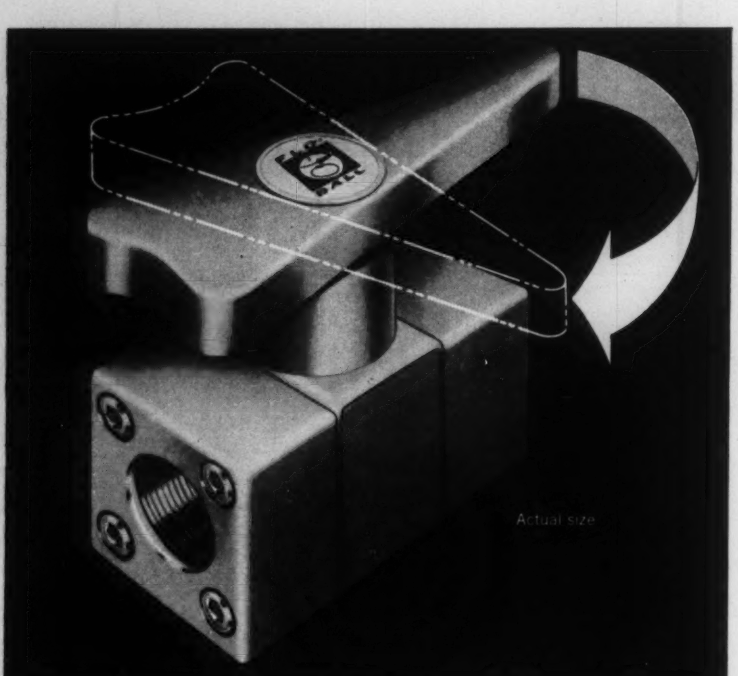
AUTOMATION CONTROLS DIVISION

GENERAL CONTROLS CO.

8062F McCormick Boulevard, Skokie, Illinois

Representatives and Distributors in Principal Cities of United States and Canada

Circle 420 on Paeg 19



Replace obsolete needle valves with the

NEW 90° ON-OFF

FLO·BALL

For 3,000 PSI...

Low torque, instant action . . . a fast 90° turn, requiring just 4 inch-pound torque at 3,000 psi, actuates the valve instantly!

Priced no higher than needle valves!

100% flow efficiency . . . straight-thru ***FLO·BALL*** design has more than twice the flow efficiency of needle valves!

Positive ON-OFF indication . . . large arrow-shaped handle shows valve position at a glance!

Zero leakage . . . Mass Spectrometer tests with Helium prove zero leakage!

Universal mounting . . . can be panel, side, bottom, or line mounted!

Removable flanges . . . damaged flanges can be removed in seconds; no need to replace entire valve!

All stainless steel construction . . . costs no more than old fashioned screw-type valve!

Versatile service . . . ideal for leak-proof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol, and many other fluids.

SERIES 715			
Port Styles and Sizes			
NPT		AND10050	
Size	Part No.	Size	Part No.
⅛	715A1	¼	715A2
¼	715B1	⅜	715B2

Other models are available for service with cryogenic and corrosive media. Also special designs for throttling flow control.

Write today for new catalog describing the world's most complete line of precision valves for industrial and military applications.

FLO· BALL

Hydromatics, Inc.

LIVINGSTON, N. J. • WYMAN 2-4900 • TWX=LIVINGSTON, N. J. 120

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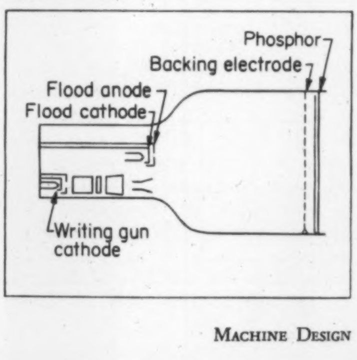
TV Tube Intensifies Picture Twenty Times

Image Retainer Sorts Out Blips from Snow for Airmen

FT. WAYNE, IND.—A new radarscope being tested for the Douglas A4D-2N Skyhawk can be read in daylight, and intensifies weak signals to stand out against static or "snow." It does the job by storing weak signals on a special screen and augmenting them until they are strong enough to be recognized. Although the original signal gives a picture with the same order of brightness as that of any television tube operating at the same potential, the storage screen "integrates" input for a determined length of time to give pictures up to 20 times as bright.

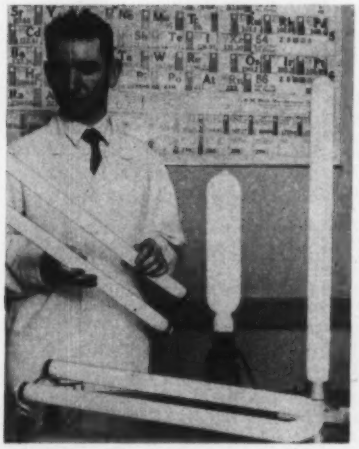
The modulated electron beam



Complete receiver weighs less than 14 lb. Designed for cramped cockpits, it occupies a space 5⅝ in. square by 16 in. deep. Simplified Iatron schematic shows location of backing screen, writing gun and flooding gun. Collimated electrons from flooding gun are controlled as they approach phosphor-coated tube face by charges on the backing screen.

from the writing gun strikes a fine-mesh backing screen directly behind the tube face. Secondary emissions from the screen are carried away by a coarser collector screen, leaving behind slight positive charges corresponding to the original signal. A second electron gun floods the screen with unmodulated, but collimated electrons. These are accelerated or repelled depending on the condition of the screen in front of them, and thus a continuous pattern of electrons corresponding to the signal falls on the phosphor-coated tube face. Repeated signals give increased image brightness.

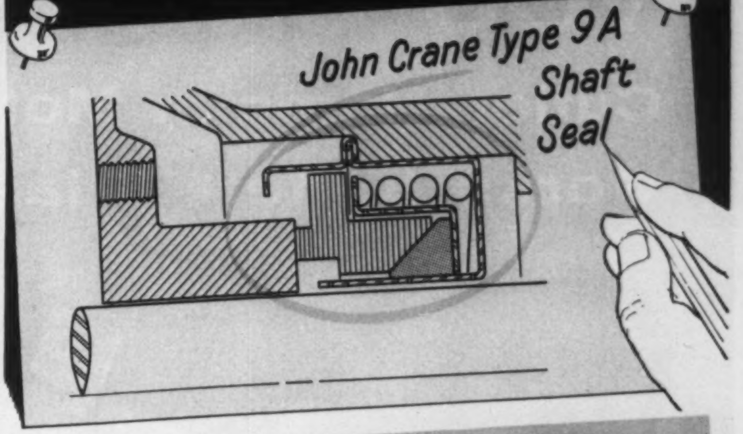
Timing of retention period is necessary. Sometimes overlapping images may be confusing. At other times, it may be desirable to see the track of a moving target. Information is "erased" from the backing screen whenever a pulse is applied to the nickel core. Frequency of erasing pulses determines time of retention. Available range is from milliseconds to minutes, but controls offered on the aircraft radarscope range from ½ to 3 sec.

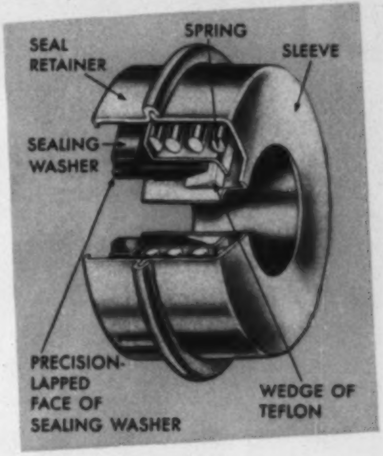


Fluorescents Take One Base

Lamp design may enter a new era with the development by Westinghouse Electric Corp., Pittsburgh, of a practical fluorescent tube with a single base. Since the new lamp requires wiring and socket for only one end, it can be mounted like a conventional incandescent lamp. Although not yet on the market, the lamp will probably find application in many decorative and unusual lighting applications.

Sealing Corrosive Liquids Starts Here . . .





This cartridge-type shaft seal designed for the production line is engineered for:

(1) positive sealing of many industrial chemicals and solvents (note the Teflon* sealing wedge);

(2) leakproof handling of inflammables and toxics;

(3) operation over a wide temperature range from −120° to +500°F., pressures to 150 psi.

It offers the Original Equipment Manufacturers these important advantages:

(1) low unit cost through mass production;

(2) fast, one-piece installation through cartridge construction;

(3) equal efficiency on both low or high speed applications, because seal does not rotate with shaft.

The 9A Shaft Seal can be of stainless steel, monel, brass or other materials adapted to stamping and forming—depending on the service requirement.

Get full details. Request Bulletin S-205-3 from Crane Packing Co., 6425 Oakton Street, Morton Grove, Illinois *(Chicago Suburb).*
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

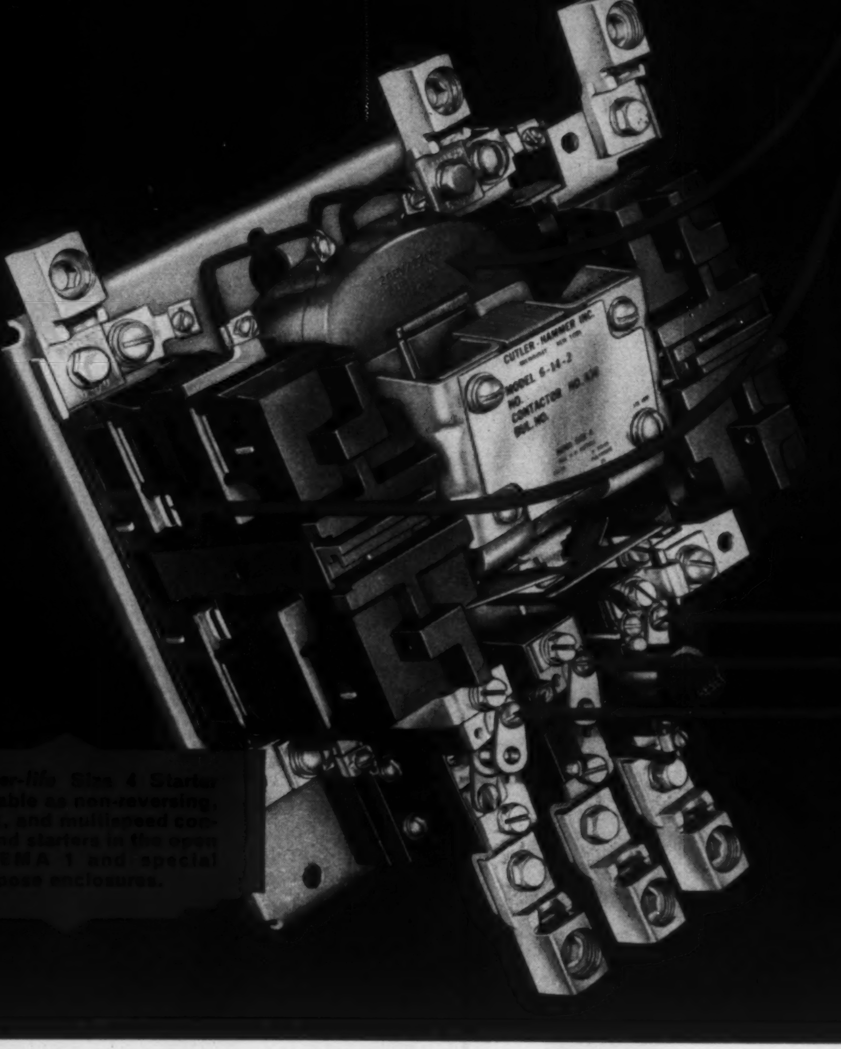
***DuPont Trademark*

John Crane
MECHANICAL PACKINGS SHAFT SEALS TEFLON PRODUCTS LAPPING MACHINES THREAD COMPOUNDS

CRANE PACKING COMPANY
OFFICES IN ALL PRINCIPAL CITIES

YOU CAN PROVE

Cutler-Hammer Motor Control works better . . . lasts longer



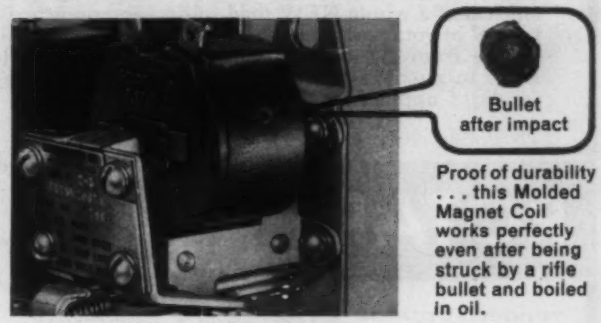
New super-life Size 4 Starter . . . available as non-reversing, reversing, and multispeed contactors and starters in the open type, NEMA 1 and special purpose enclosures.

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

MOLDED MAGNET COILS

The strength and durability of the Cutler-Hammer Molded Magnet Coil is but one example of how Cutler-Hammer Motor Control is built better to last longer. Rifle bullets couldn't pierce or shatter this coil. What chance is there of it being damaged when an electrician's screwdriver slips or when the coil is dropped? Boiling oil has no effect on this coil. What chance is there of it ever being penetrated by moisture or distorted by high ambient temperatures?

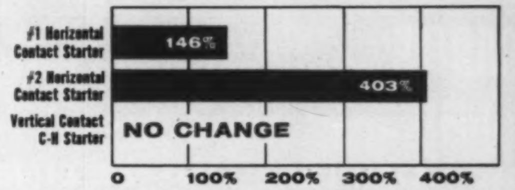


Proof of durability . . . this Molded Magnet Coil works perfectly even after being struck by a rifle bullet and boiled in oil.

VERTICAL DUST-SAFE CONTACTS

To function properly motor control contacts *must* stay clean. And because dust can't collect on a vertical surface, only vertical contacts are truly *dust-safe*. Recent dust-chamber tests of vertical and horizontal contact type motor starters confirm this fact. After four hours of "dusting," the contact resistance of Cutler-Hammer vertical contacts remained constant. But the contact resistance of horizontal contacts skyrocketed, and as contact resistance increases so does heating, pitting, and wear resulting in rapid contact failure.

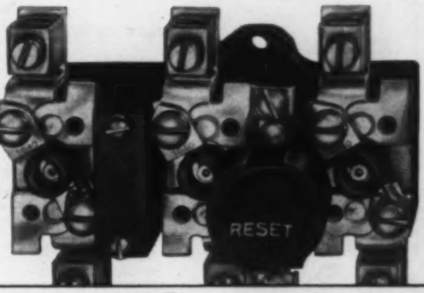
PERCENT GAIN IN CONTACT RESISTANCE DUE TO DUST

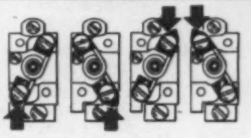


Dust Environment Test of Vertical and Horizontal Contact Type Motor Control

ADJUSTABLE 3-COIL OVERLOAD RELAYS

Only 3-coil overload relays can provide dependable overload protection for three-phase motors under all operating conditions. Why gamble with costly motor burnouts by using motor control that protects only two of the three motor windings? 3-coil overload relays can be provided in all standard Cutler-Hammer Motor Control, no oversize enclosures, or as an open component for low cost panel mounting. Further, Cutler-Hammer Overload Relays are adjustable to within 3% of full load motor current, not 10% or 12% as others. Cutler-Hammer Overload Relays allow the motor to work up to full capacity, provide positive protection without nuisance tripping.





Heater coils can be placed in any of the four positions to adjust the overload trip point to within 3% of full load current.

Molded magnet coils, vertical *dust-safe* contacts, and adjustable 3-coil overload relays are *plus* features that add up to bonus performance wherever Cutler-Hammer Control is used. Why settle for less when Cutler-Hammer Motor Control costs no more. Write today for Pub. EN150-J243. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

This revolutionary Carter Rotary Torque Actuator gives engineers a whole NEW field of design opportunities! Up to 370° of rotary fluid power as standard... Safe, powerful torque from air, oil, gas or water power. Zero leakage! Built in cushions! Infinite positioning flexibility! Thousands of applications!

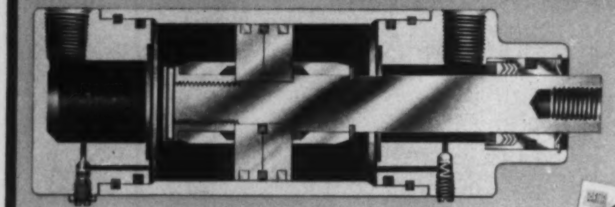
ROTARY

TORQUE ACTUATOR
0-100°
0-190°
0-280°
0-370°
as standard
PNEUMATIC or HYDRAULIC

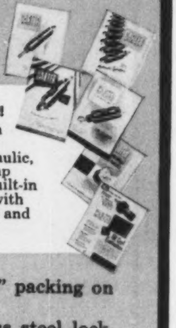
Patents Pending

Send for 12-page Bulletin with complete engineering data.

CARTER offers unlimited cost-cutting design opportunities through industry's only COMPLETE LINE of LINEAR and ROTARY fluid power actuators!



HYDRAULIC AND PNEUMATIC CYLINDERS



Complete Catalog File!
Complete bound file with ordering details for: Air Cylinders, 750 PSI Hydraulic, 1500 PSI Hydraulic, Clamp Cylinders, Air Valves, Built-in Valve Types. Complete with parts data, specifications and prices. Send today!

LINEAR

1. Space saving designs! Light weight!
2. Full 1 to 1 Meehanite cartridge rod bearing.
3. Precision honed heavy wall tubing—6 to 1 safety factor.
4. Spring loaded "V" packing on rod end gland.
5. Key type stainless steel locking ring. Allows 360° rotation of pipe ports.

IMMEDIATE DELIVERY ON ALL STANDARD CYLINDERS AND ACTUATORS

CARTER CONTROLS, INCORPORATED
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Phone: BAyport 1-7186 (Chicago) • GRanite 4-3305 (Lansing, Ill.)

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Metals Matters

High-temperature alloys . . .
of ceramic and copper with four times the strength of copper at high temperatures and a room-temperature ductility only 30-40 per cent below that of copper are being studied at the University of Denver. Scientists working on the project see no reason why the melt-saturation process used could not be applied to other metals as well. Brittleness and strength properties of the alloy would depend on properties of the metal and ceramic used.

Temperatures over 4500 F . . .
are resisted by GRB silicon carbide (graphite bonded in silicon carbide). The product weighs 2.3 to 2.8 g per cc; has a transverse strength of 5000 to 12,000 psi at 2550 F. Resistance to oxidation, erosion, and thermal cracking is observed in oxyacetylene torch tests of sample rocket nozzle inserts by the Carborundum Co., Niagara Falls, developer. Weight ratio of silicon carbide is 60 to 90 per cent. The remainder is bonded graphite particles which contribute thermal shock resistance.

Spray-on fireproof coat . . .
of organic ceramic protects metals from gas erosion and high temperatures. It can be applied with ordinary industrial spray equipment. No enameling or atmospheric curing ovens are required. High dielectric strength, flexibility and thermal-shock resistance of −100 F are among its properties, says Dyna-Therm Chemical Corp., Culver City, Calif. It has adhered well on all metals tested, including "exotic" alloys. As a temperature-insulating coating it is now being used on production-line Nike-Ajax and Nike-Hercules missiles.

Nonporous sintered parts . . .
are made by impregnating the pores with a thermo-setting plastic resin by the National Sinter-Seal Co., Buffalo, N. Y. Seal is not affected by plating solutions, moisture, oil, or most solvents. It can withstand intermittent temperatures up to 400 F.

Tubes work better . . .
when cathodes are made of new vacuum-melted nickel developed by RCA. Increased purity and close control of desirable trace elements give the metal, N132, predictable characteristics. Cathodes made from this metal show better performance and more reliability than cathodes made of conventional air-melted nickel.

Machine Design Appoints Assistant Editor

CLEVELAND—Richard A. Jacobson has joined the staff of MACHINE DESIGN as an assistant editor.

A graduate of Fenn College, Cleveland, Mr. Jacobson holds a B. S. degree in engineering physics. He was a research engineer for the American Gas Association for five years prior to joining MACHINE DESIGN.

Richard A. Jacobson

Mr. Jacobson's present assignment is preparation of material for the Engineering News section.

Meetings
AND EXPOSITIONS

May 25-27—

American Society for Quality Control. Annual Convention and All Industry Production & Quality Control Exposition to be held at Public Auditorium, Cleveland. Further information is available from society headquarters, 161 W. Wisconsin Ave., Milwaukee 3, Wis.

May 25-28—

Design Engineering Show and Conference to be held at Convention Hall, Philadelphia. Confer-

Revolutionary Gear Development!

Eliminates damaging effects of
— misalignment
— shaft deflection
— tooth distortion

Sier-Bath
CROWN-GROUND
CASE-HARDENED
SPUR and HELICAL
GEARS

OTHER ADVANTAGES

- Compensates for unbalanced rotation
- Eliminates causes of "end bearing"
- Produces more uniform accuracies
- Permits greater variety of tooth forms
- Carries greater loads at higher speeds
- Operates with extreme quietness
- Increases machine production and life

Your machines need no longer be limited by the inability of gears to withstand the punishing demands of deflections—greater loads—and continuous high speed operation.

Sier-Bath Crown-ground case-hardened gears upgrade the values of existing gear formulae, giving you new design latitude and your machines new production capabilities never before obtainable.

IF YOU ARE USING GROUND TOOTH GEARS, these Sier-Bath Crown-ground gears cost the same as, and often less than, commercially-made ground tooth gears.

See these "Gears of Tomorrow" Demonstrated at BOOTH 1548, Design Engineering Show

Or, write for a Sier-Bath gear engineer to explain the vast improvements possible in your machines, by using Crown-ground case-hardened gears instead of ordinary gears.

Sier-Bath
PRECISION
GEARS

Sier-Bath GEAR & PUMP CO., Inc.
9237 HUDSON BOULEVARD NORTH BERGEN, N. J.
Founded 1905 Members A.G.M.A.

Also manufacturers of Rotary Pumps and Flexible Gear Couplings

A VISION of VERSATILITY . . .
The COMPLETE LINE of
RBC
BEARINGS

Each a gem of modern engineering technology . . . from the NEW Miniature Roller Bearing designed for today's precision electronic and rocketry applications . . . through the Pitchlign Series demanded by industry for its superiority . . . to the Heavy Duty Self-Aligning Bushing Assembly respected for rugged dependability.

. . . on exhibition at
BOOTH 221,
Design Engineering
Show, May, 25-28

For engineering data on the RBC Bearing line, write for Catalog

RBC
ROLLER BEARING COMPANY OF AMERICA
Sullivan Way, West Trenton, N.J.

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ence is sponsored by the Machine Design Div. of ASME. Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

June 4-5—
Institute of Radio Engineers. Third National Conference of the Professional Group on Production Techniques to be held at the Villa Hotel, San Mateo, Calif. Further information is available from William C. Estler, 965 Lincoln Ave., Palo Alto, Calif.

June 7-11—
American Society of Heating and Air-Conditioning Engineers. Semiannual Meeting to be held in Vancouver, B. C. Additional information can be obtained from society headquarters, 62 Worth St., New York, N. Y.

June 9-11—
Material Handling Institute's Exposition of 1959 to be held at the Public Auditorium, Cleveland. Technical sessions are sponsored by the American Material Handling Society Inc., with the co-operative endorsement of the Society of the Advancement of Management and the American Society of Mechanical Engineers. Further information is available from MHI headquarters, Suite 759, 1 Gateway Center, Pittsburgh 22, Pa.

June 14-18—
American Society of Mechanical Engineers. Semiannual Meeting to be held at the Chase-Park Plaza Hotel, St. Louis. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

June 14-19—
Society of Automotive Engineers Inc. Summer Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Additional information can be obtained from society headquarters, 485 Lexington Ave., New York 17, N. Y.

June 16-19—
Institute of the Aeronautical Sciences. National Summer Meeting to be held in Los Angeles. Further

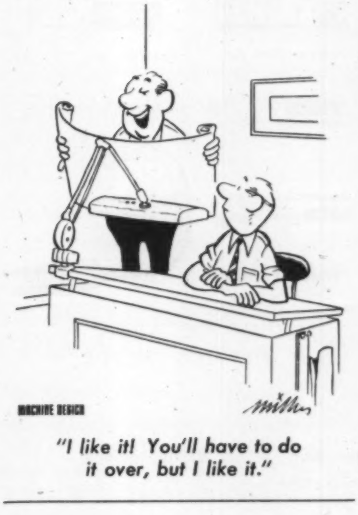
information can be obtained from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

June 17-20—
National Society of Professional Engineers. Engineering Progress Exposition to be held at the Hotel Commodore, New York. Further information is available from exposition headquarters, 331 Madison Ave., New York 17, N. Y.

June 18-20—
American Society of Mechanical Engineers. Applied Mechanics Div. Conference to be held at Virginia Polytechnic Institute, Blacksburg, Va. Further information can be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

June 22-24—
American Society of Refrigerating Engineers. Annual Meeting to be held at the Lake Placid Club, Lake Placid, N. Y. Additional information is available from society headquarters, 234 Fifth Ave., New York 1, N. Y.

June 22-26—
American Society for Testing Materials. Annual Meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Further information can be obtained from ASTM headquarters, 1916 Race St., Philadelphia 3, Pa.



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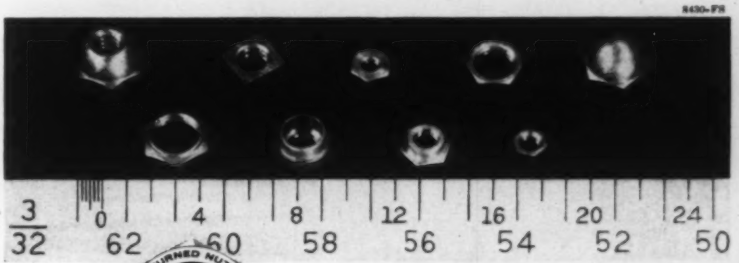

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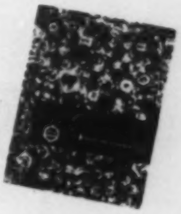

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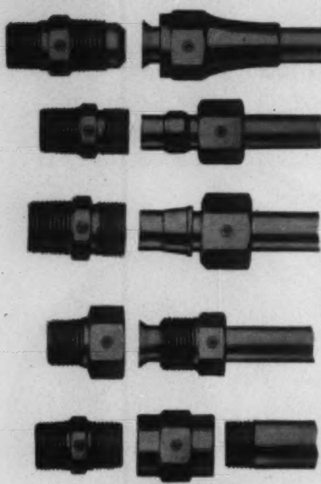
brass tube fittings



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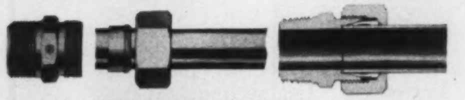

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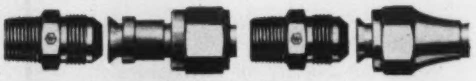

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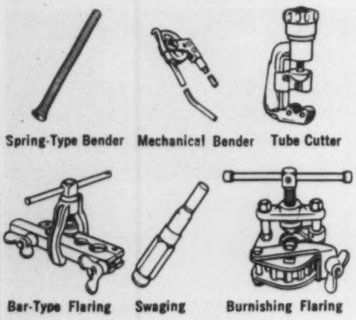

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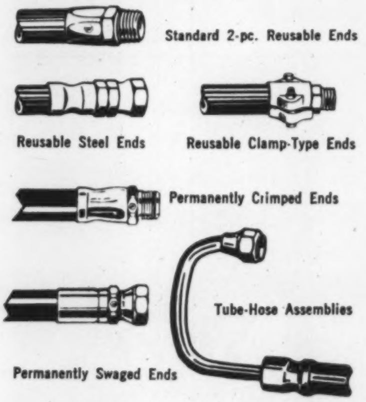

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GENERAL ELECTRIC

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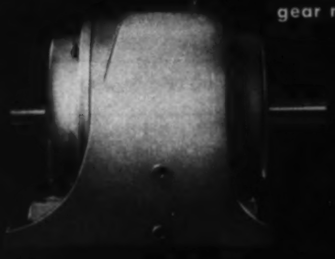
Integral-type gear motor

All-motor gear motor

Right-angle shaft gear motor

Offset-shaft gear motor


New helical speed reducer

New shaft-mounted speed reducer

DESIGNING WITH ALUMINUM

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Illinois.

NO. 30

ALUMINUM IN LOW TEMPERATURE APPLICATIONS

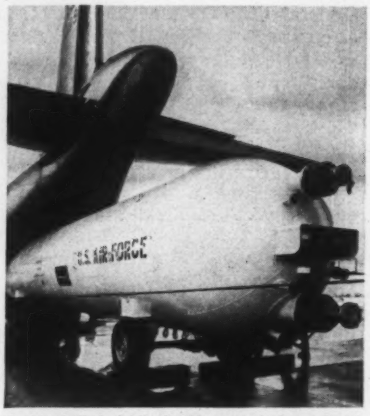
THE STRUCTURAL QUALITIES of aluminum and its alloys are actually improved at ultra-low levels of temperature, such as are encountered in the manufacture and handling of liquid gases. Tensile and yield strengths rise markedly, and percentage of elongation increases. As the lowest-cost metal capable of performing satisfactorily at temperatures below −150°F., aluminum is thus valuable to the rapidly expanding field of cryogenic applications.

Aluminum alloys also are unique among commercial metals in their combination of high strength-weight ratio, corrosion resistance, formability, weldability, reflectivity, and conductivity of heat and electrical energy. Also important for purposes of handling volatile liquids, aluminum is non-sparking, nonmagnetic and non-toxic.

The requirements of commercial gas applications are filled chiefly by four industrial gases (see Figure 1). Oxygen, nitrogen, argon and helium—in that order of volume—comprise much the greater portion of commercial gas manufacture. Oxygen, nitrogen and argon are among the gases that are produced by liquefying air at −320°F. to effect a separation of each gas at its individual boiling point as a liquid. Equipment for this production can use, and has used, large quantities of aluminum alloy sheet, plate, extrusions, tubing and pipe.

These gas products, along with natural gas (mostly methane) are reduced by cooling and liquefaction to volumes only about 1/600 to 1/800 of their gaseous volume. *And because consumption by industry in both old and new applications currently amounts to hundreds of millions of cubic feet annually,* this reduction in handling bulk is of immense economic importance.

One of the latest military missiles, for example, consumes 420 cubic feet of liquid oxygen . . . 336 thousand cubic feet as gas . . . in a 90-second firing period. These liquefied gases may be stored and moved in aluminum alloy double-shelled insulated tanks, thus taking advantage of their extreme concentration in the low-temperature liquid state.



Double-shelled mobile liquid-oxygen tank, produced with Kaiser Aluminum alloy 5086. Used in fueling missiles, this tank is being loaded for transport by air.

FIGURE 1

SOME PROPERTIES OF COMMERCIAL GASES

	BOILING POINT OF LIQUID GAS (Fahrenheit)	LIQUID DENSITY AT BOILING POINT (Lbs./cu.ft.)	GAS DENSITY* (Lbs./cu.ft.)	APPROX. VOLUME INCREASE, LIQUID TO GAS*
OXYGEN	−297	71.2	0.089	799
NITROGEN	−321	50.4	0.078	650
ARGON	−302	88.02	0.1114	770
HELIUM	−452	7.82	0.0111	700
NATURAL GAS (Chiefly Methane)	−265	25.9	0.0447	580

* Gas at normal temperature and pressure.

FIGURE 2

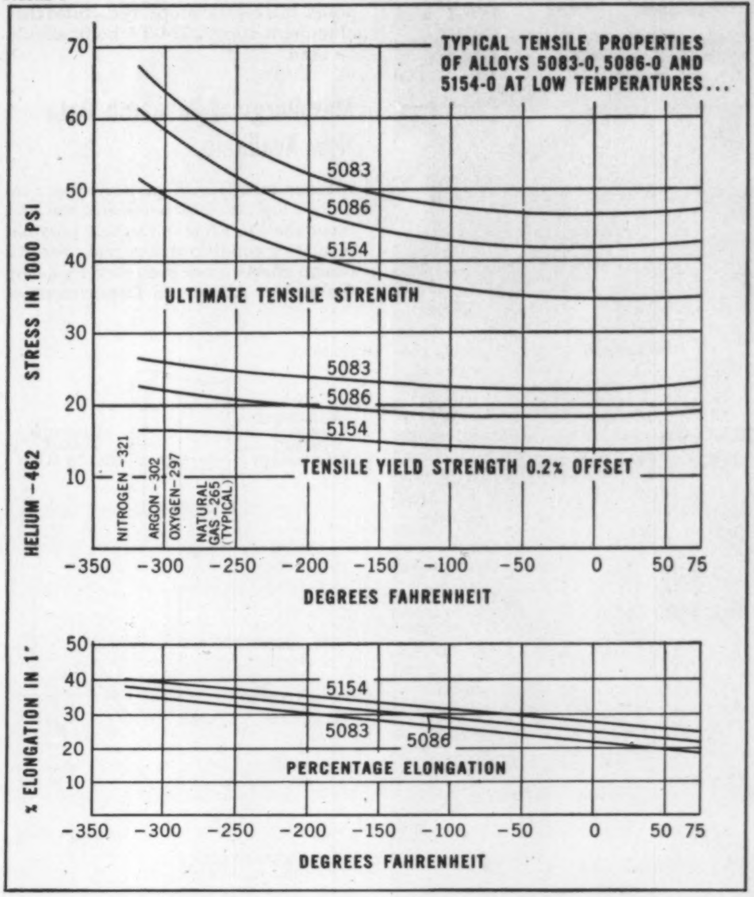
TYPICAL TENSILE PROPERTIES OF SOME ANNEALED ALUMINUM ALLOYS APPROVED BY ASME FOR UNFIRED PRESSURE VESSELS

ALLOY DESIGNATION		ASME SECTION OR CASE NO.	TENSILE STRENGTH (psi)		ASME ALLOWABLE DESIGN STRESS * VALUES (psi)	MINIMUM REQ'D WELDED TENSILE STRENGTH (psi)	PERCENT ** ELONGATION
AA	ASTM		Ultimate	Yield			
1100	990A	8	13,000	5,000	2,350	11,000	35
3003	M1A	8	16,000	6,000	3,150	14,000	30
3004	MG11A	8	26,000	10,000	5,650	23,000	20
5050	G1A	8	21,000	8,000	4,000	18,000	24
5052	GR20A	8	28,000	13,000	6,250	25,000	25
5154	GR40A	1174	35,000	15,000	7,350	30,000	27
5086	GM40A	1222	38,000	17,000	8,700	35,000	22
5083	GM41A	1247	42,000	21,000	10,000	40,000	22

* For metal temperature not exceeding 150°F.
** In 2 inch flat $\frac{1}{16}$" gauge specimen at 75°F.

Nominal chemical compositions:
5154—Magnesium 3.5%, Manganese 0.05%, Chromium 0.25%
5086—Magnesium 4.0%, Manganese 0.45%, Chromium 0.15%
5083—Magnesium 4.45%, Manganese 0.75%, Chromium 0.15%

FIGURE 3

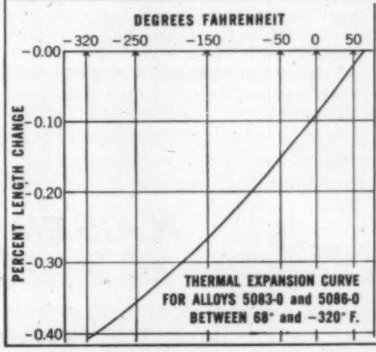


Several weldable aluminum alloys have been approved by the American Society of Mechanical Engineers as safe and suitable for construction of unfired pressure vessels such as are used in the handling of liquid gases.

Figure 2 tabulates typical tensile properties and the design stresses permitted by the ASME Code for some of these alloys, including high strength aluminum-magnesium compositions. All values shown are for metals in the annealed state. Kaiser Aluminum alloys 5083 and 5086 are the strongest ASME-approved aluminum-magnesium-manganese alloys that can be fabricated into these welded vessels by all normal methods, without need for stress-relieving or annealing. Both of these Kaiser alloys 5086 and 5083, when welded with 5183 filler, also meet the stringent "2T" bend test requirements for welds established by ASME for most other materials in these unfired pressure vessel applications.

The allowable design stress values shown are specified by ASME as acceptable for vessels and appurtenances from 150°F. down to -325°F. These permissible values are roughly two-thirds of the minimum guaranteed yield strength of the alloy at room temperature. Since the ultimate tensile and yield strengths of aluminum alloys increase as temperatures drop, the margin of safety rises still further at liquid gas temperature levels.

FIGURE 4



THERMAL EXPANSION COEFFICIENTS OF ALUMINUM ALLOYS AT LOW TEMPERATURES

Average Coefficients of Thermal Expansion ($\times 10^{-6}$ per degree F.)

ALUMINUM ALLOYS	68° to -200° F.	68° to -320° F.
1099	11.8	10.5
3003	11.2	10.0
5083	11.6	10.4
5086	11.6	10.4
6061	11.3	10.2
#304 Steel (Stainless)	7.7	7.4

The low temperature behavior of alloys 5154, 5086 and 5083 is exemplified approximately in Figure 3. Ultimate strengths increase by about 50% from room temperature to -320°F. Yield strengths rise by about 18%. Thus, at the -320°F. level, the yield strengths of these three high-strength alloys approximate 2¼ times the stresses allowed for pressure vessel design by the ASME Code.

Through the same temperature range, percentage elongation properties have been shown by test to increase 60% or more, reaching the magnitude of 40% elongation at -320°F.

This added strength and ductility contribute much to structural dependability against both mechanical shock and large temperature differentials in different portions of the same aluminum part or system.

The thermal contractions encountered in ultra-low temperature equipment are larger than those to be accommodated in ordinary design applications. For example, an aluminum member 25 feet long contracts by about 1¼-inch through the range from 68° to -325°F. Figure 4 shows these thermal expansion characteristics, as typified by aluminum alloys 5086 and 5083.

The low elastic modulus of aluminum also contributes to its suitability for low-temperature equipment by mitigating the adverse effects of thermal contraction. Thermal deformations cause much smaller increases or decreases of stress in aluminum parts than in equivalent stainless steel parts. The representative #304 stainless steel listed in Table 4 will contract only about 70% as much as the high strength weldable aluminum alloys, for any given drop in temperature. However, the aluminum alloys have an elastic modulus of about 10,300,000 psi, roughly one-third that of the steel. Because of this difference in elastic moduli, the stress changes resulting from thermal deformation through any given temperature change

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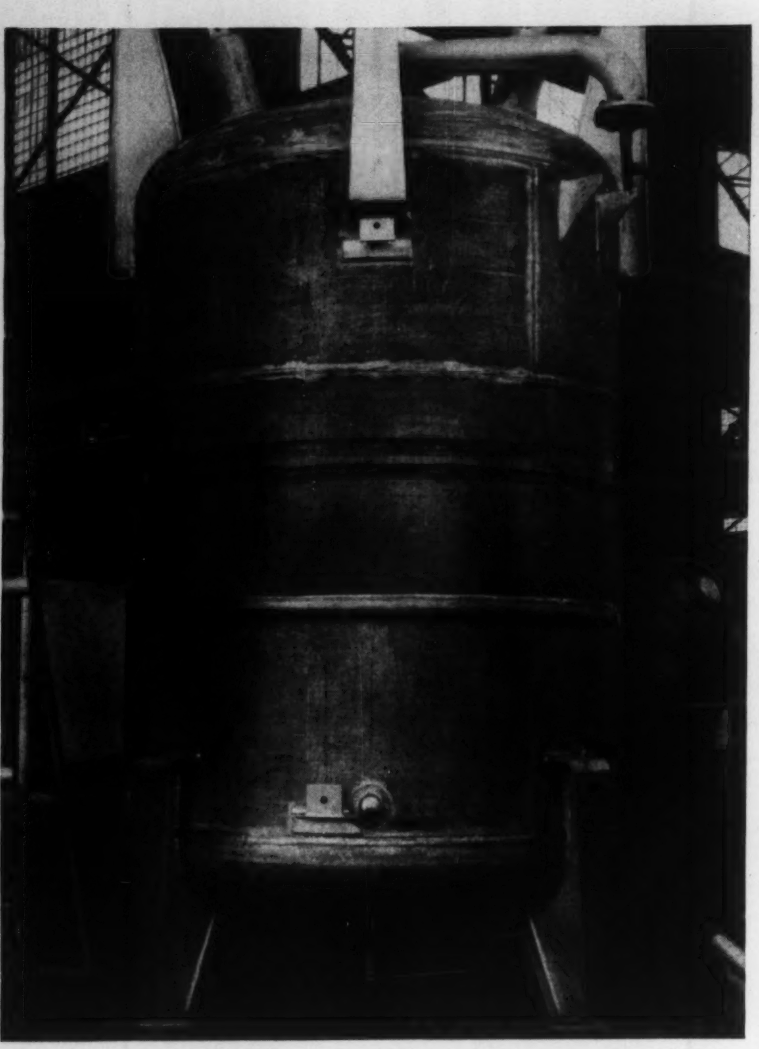


Assembly of welded aluminum vessel for a liquid-oxygen generating plant. Such plants serve the steel and chemicals industries.

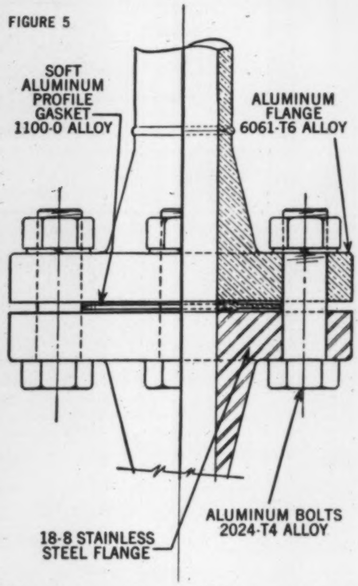
will be lower in the aluminum than in the steel.

One example of the advantages offered by this capacity for large elastic thermal deformations is the ability of aluminum alloy flanged joints, using 2024-T4 aluminum bolts, to maintain joint tightness under cyclical temperature conditions between 250°F. and –320°F. A bolt-loosening effect naturally occurs during the initial contraction of the pipe bore as it is cooled to liquid-gas temperatures, while the outer flange and the bolts remain relatively uncontracted at ambient levels. This tends to reduce gasket seating pressures. However, the loss of stress in aluminum bolts and flanges during thermal contraction of the pipe is much less than that occurring in equivalent steel parts. This ability to maintain stress during thermal deformations, along with the use of a soft aluminum profile gasket next to the bore, maintains adequate sealing while the flanges and bolts also cool. Since it often is desirable to bolt an aluminum flanged line to a stainless steel flanged line, for heat-dam purposes, this elastic property dictates that aluminum alloy 2024-T4 bolts should be used.

Metallurgical Research Data Now Available

Since most liquid-gas containers require a high vacuum between outer and inner shell to achieve the best possible insulating conditions, external pressure design charts have been developed by the Kaiser Aluminum Department of Metallurgical Research for each of the high strength alloys. These charts, and other information on aluminum use in low temperature applications, are available to interested manufacturers.

FIGURE 5


SOFT ALUMINUM PROFILE GASKET 1100-0 ALLOY
ALUMINUM FLANGE 6061-T6 ALLOY
ALUMINUM BOLTS 2024-T4 ALLOY
18-8 STAINLESS STEEL FLANGE

For immediate attention to your request for these charts and other technical information—or for engineering assistance in your own applications—contact the Kaiser Aluminum sales office listed in your telephone directory.

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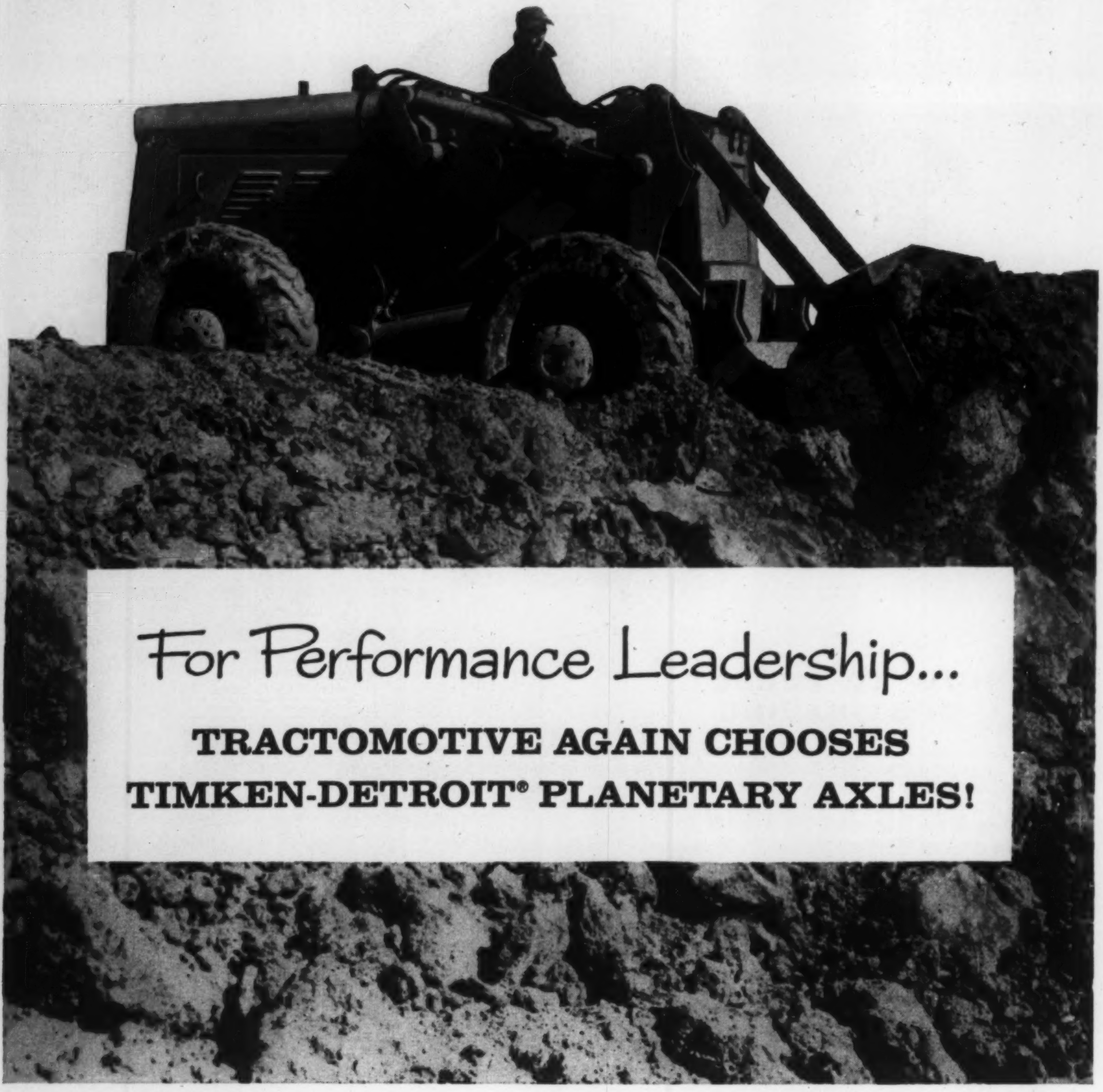

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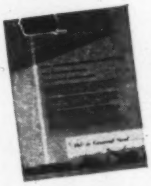

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Circle 434 on Page 19

Circle 435 on Page 19→

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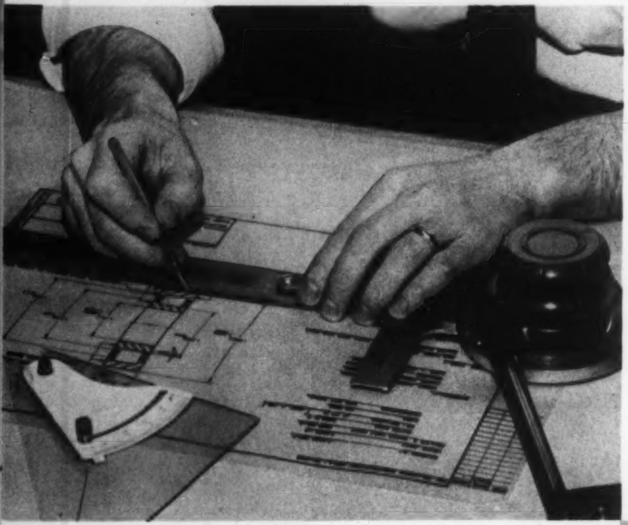

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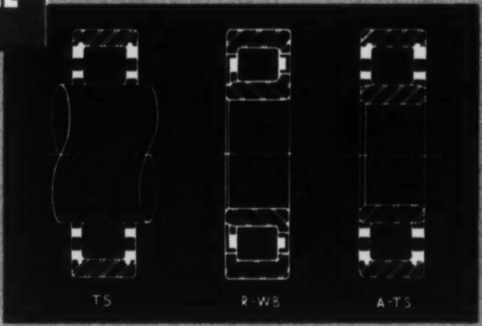
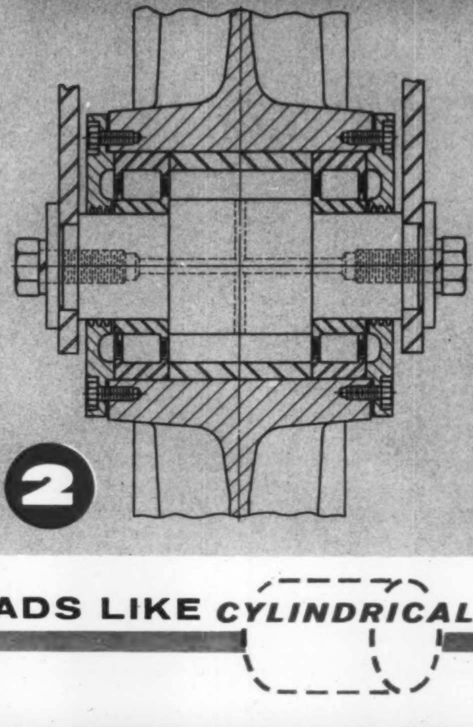


1 Because of HYATT Hy-Roll bearings' inherently greater load capacity, you can often reduce envelope dimensions by carrying a given load on a smaller series or smaller shaft size HYATT, compared with other types of bearings.

2 When bearing length is the critical factor, you can often reduce it by substituting a HYATT Hy-Roll bearing which has greater load carrying capacity for a given roller length.

3 If a larger, more rigid shaft is required without increasing the size of the housing bore, a HYATT Hy-Roll bearing with *separable inner race* will often solve the problem. By eliminating the inner race and operating the bearing rollers directly on the hardened and ground shaft, the space usually occupied by the inner race becomes available for a shaft of larger diameter.

4 Similarly, when space limitations make it necessary to reduce the diameter of the housing bore without decreasing shaft diameter, a HYATT Hy-Roll bearing with *separable outer race* is the answer. By eliminating the outer race and operating the bearing rollers directly on the hardened and ground bore, you can save the space normally occupied by the outer race.



NO BEARINGS CARRY RADIAL LOADS LIKE *CYLINDRICAL*

MORE LOAD IN LESS SPACE

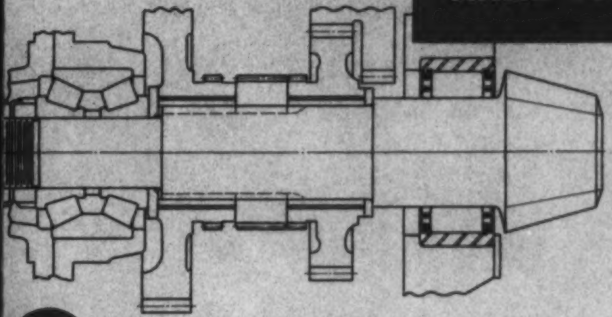
THE DESIGNER'S DILEMMA

One of the problems facing design engineers more and more frequently these days is the result of two contrary trends in modern machine design. On one hand, higher horsepowers require heavier shafts and impose greater radial loads on bearings. At the same time there is continual pressure to reduce envelope and housing dimensions, to save space and weight wherever possible. The only answer is to find bearings which will carry more load in less space.

THE ANSWER: CYLINDRICAL BEARINGS

It is a well-known (though sometimes overlooked) fact that the geometry of a cylindrical roller bearing results in *inherently greater radial load-carrying capacity* than any other type can offer, simply because there is a larger area of contact between races and rollers. Most designers are also aware that straight cylindrical bearings provide the lowest roller bearing friction characteristics because this type most closely approaches true rolling action.

THREE TYPICAL APPLICATION EXAMPLES



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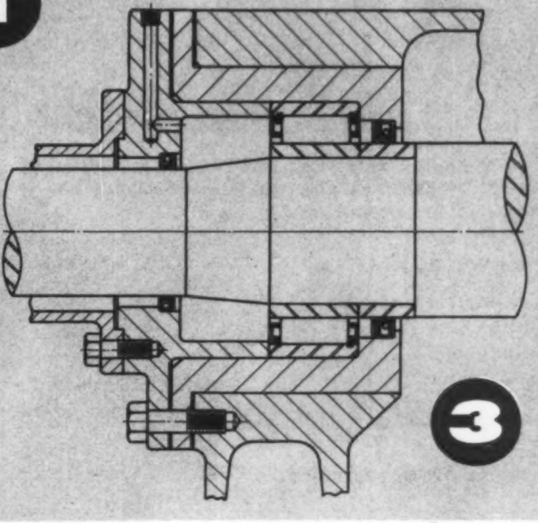


3

OVERHUNG PINION IN LIFT TRUCK TRANSMISSION: (Figure 1) HYATT Hy-Roll Type TS provides the load-carrying capacity so necessary in this heavily loaded position. By eliminating the separable inner race, it was also possible to use a larger, more rigid pinion shaft without disturbing the boundary dimensions of the bearing.

ELEVATOR SHEAVE: (Figure 2) In applications such as this which require heavy load-carrying capacity, long life and quiet operation, HYATT Hy-Roll Type R-WB has proved extremely successful. This is also an excellent example of stationary shaft application where cylindrical bearings provide dependable end location.

FLOATING HERRINGBONE PINION IN PUMP: (Figure 3) Here HYATT Hy-Roll Type A-TS provides great load-carrying capacity in limited space, plus the all-important "free lateral" movement necessary to enable the herringbone pinion to track in its proper location. Note also that spacer is a standard HYATT inner race which provides a hardened and ground surface for the seal, very simply and economically.

BEARINGS . . . AND NOBODY KNOWS THEM LIKE HYATT

YOU CAN DEPEND ON
THE ADVICE OF YOUR
HYATT
SALES ENGINEER

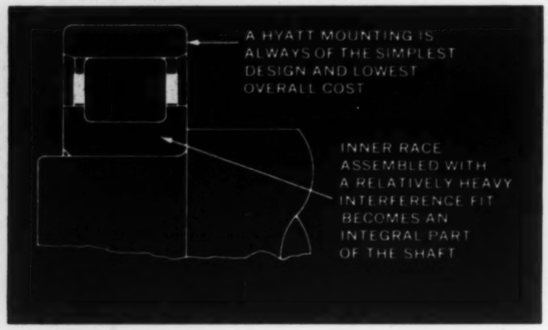
...and the bearings
he recommends!

Quality **DESIGNED**

HYATT pioneered the cylindrical roller bearing two-thirds of a century ago, and today HYATT engineers draw on this unequalled fund of accumulated know-how to design superior performance into every HYATT Hy-Roll Bearing.

Quality **CONTROLLED**

The most modern electronic feed-back control of grinding operations, extremely close control of internal diameters and clearances, and uncompromising standards of final inspection assure longer life for every HYATT Hy-Roll Bearing.

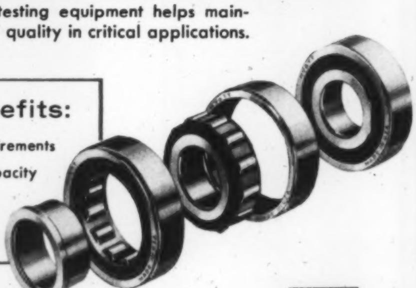

A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT

HYATT originated carburized inner races which permit heavy interference fits and eliminate holding devices.

Ultrasonic testing equipment helps maintain HYATT quality in critical applications.

Remember these *BUILT-IN* HYATT Benefits:
- Higher radial load-carrying capacity, size for size
- Minimum space requirements
- Omitted races are optional
- Shaft location without sacrificing capacity
- Easier assembly and disassembly
- Heavier press fits simplify retainment

THE HEAVIER THE LOAD THE MORE YOU NEED...

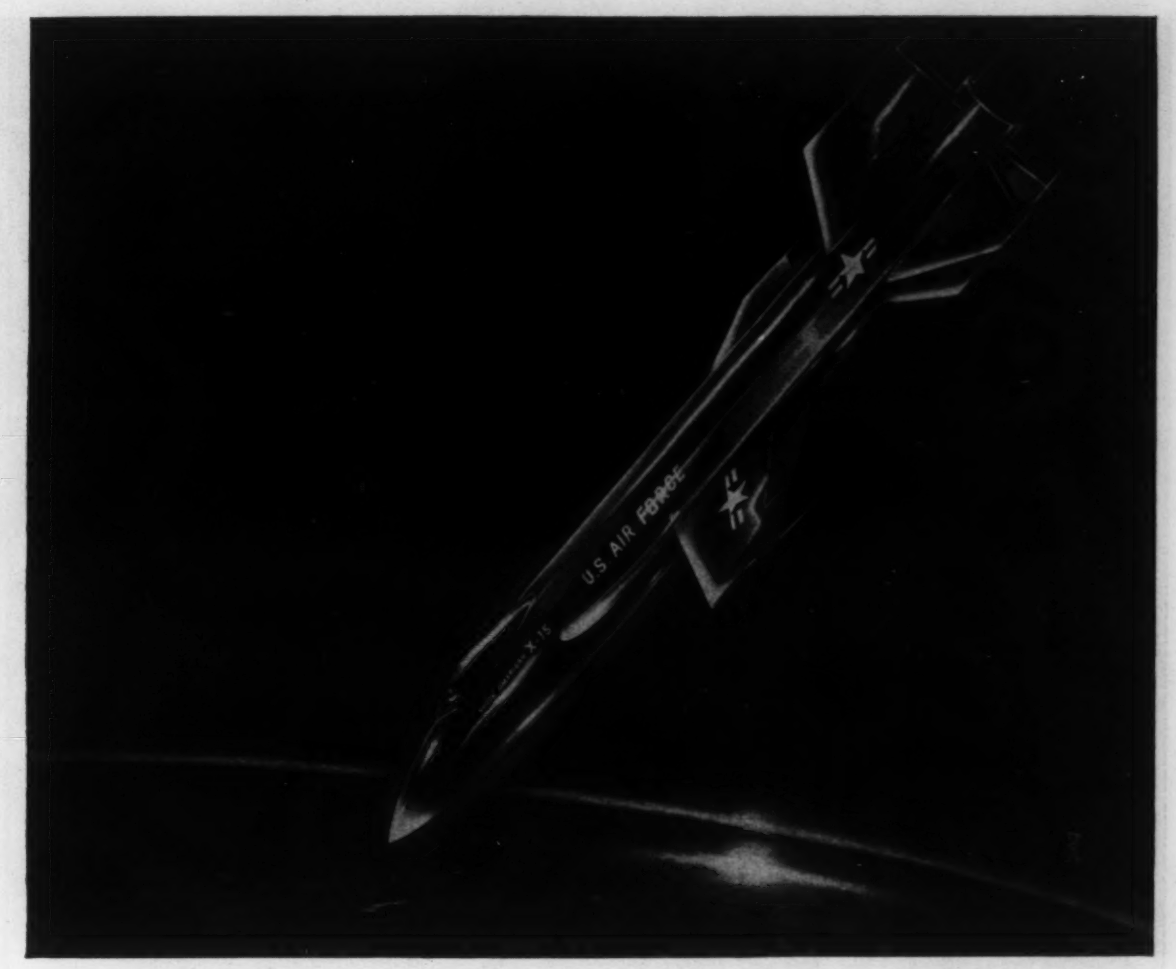


THE RECOGNIZED ***LEADER*** *IN CYLINDRICAL BEARINGS*

GM
GENERAL MOTORS

HYATT ***HY-ROLL BEARINGS***
FOR MODERN INDUSTRY

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY



Streaking down to earth from space, X-15's skin of Inconel "X" alloy will glow with the dull cherry red of a tossed rivet. X-15, the first manned space-probe ship, is built by North American Aviation, Inc.

How X-15 survives red-hot re-entry

When the first manned space-probe ship, X-15, streaks in from space to re-enter the earth's atmosphere, air friction heats its nose and leading edges to a dull, glowing red in seconds.

Temperatures as high as 1000°F build up. Temperatures that could easily weaken the skin of the X-15. Temperatures that *melt* aluminum. *Deform* carbon steels. *Destroy* most other materials.

How could designers make it possible for X-15 and her pilot to return safely?

The answer was found in the high-temperature properties of Inconel "X"*, an age-hardenable nickel chromium alloy. Inconel "X" alloy offers the high-temperature strength X-15 needs to make its red-hot comeback into earth's atmosphere.

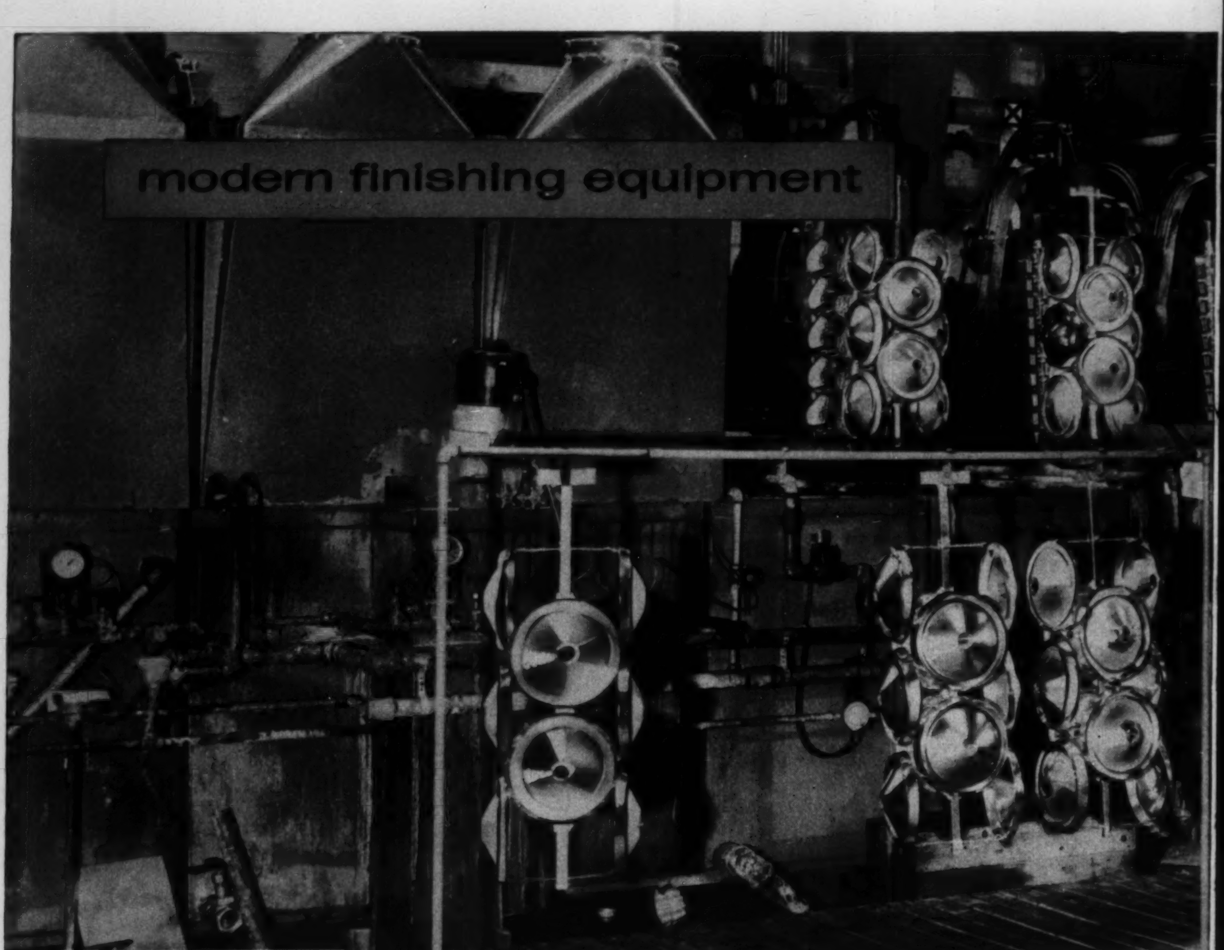
Does this versatile alloy suggest a way you can get some problem facing you off the ground? Inconel "X" alloy provides good spring properties as high as 1000°F. Its relatively low coefficient of expansion makes it useful for parts which must move within tight clearances at high temperatures. And its oxidation and corrosion resistance at high temperatures are outstanding.

If your design problem involves high or low temperatures, corrosion, stress, fatigue . . . or perhaps a combination of these conditions . . . talk it over with us. One of the versatile Inco Nickel Alloys may be able to bring one of your designs back "home" safely and economically. Write for our new booklet, "High Temperatures Spur Use of Nickel-Base Alloys" for "red-hot" information. It's yours for the asking.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N.Y.

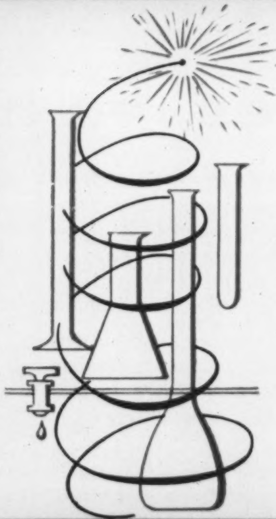
*Trademark of The International Nickel Company, Inc.

INCO NICKEL ALLOYS



modern finishing equipment

Gilbert Gleichner, "pushbutton electro-chemist" and operator of our newest Stevens automatic anodizing unit. Bert says he's getting more done, better, in less time, than he ever has before.

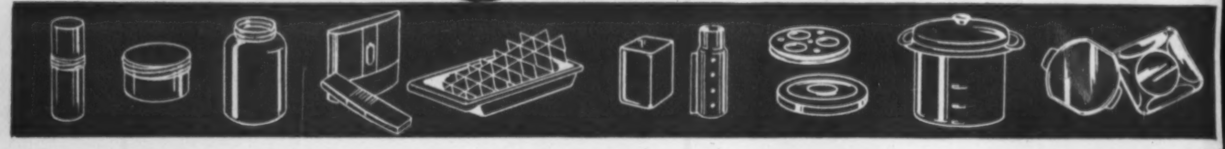


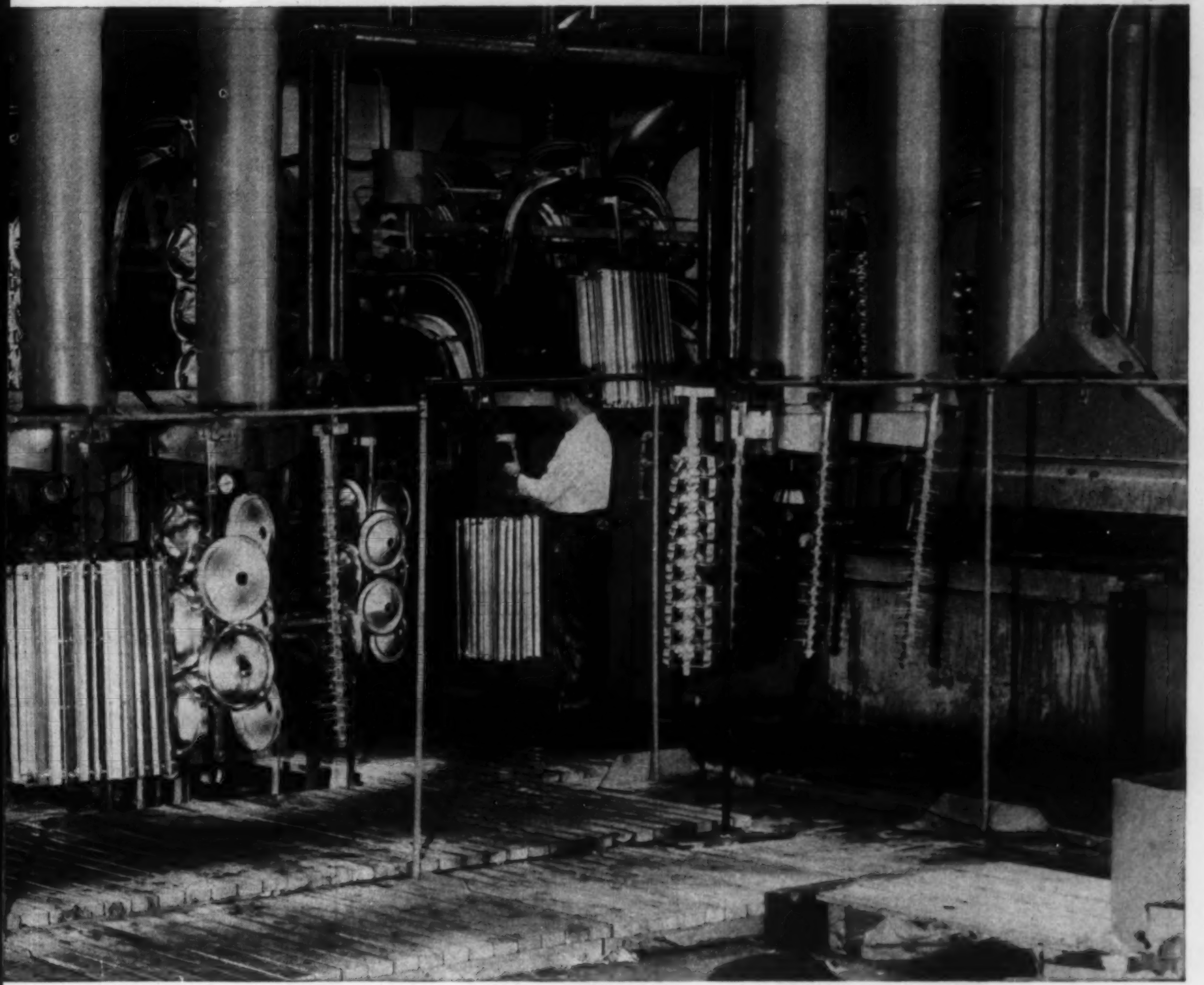
...a part of

FOR

This mechanical wonder, a completely automatic anodizing unit, can carry thousands of component parts through the entire anodizing process at a predetermined cyclical rate that sets up optimum immersion for the job in hand, ***ruling out the human element of variation in manual and semi-automatic operation!***

Benefits to you are obvious. A finer anodic finish in natural, bright, or color . . . at lower cost . . . with on-schedule delivery. And, best of all, components in *final* form, ready for





our complete facilities

FABRICATING YOUR COMPONENTS

application to your product on your own assembly line.

Why not review your component requirements? If it can be made of aluminum—stamped, drawn or rolled-formed—and you need large volume, high-speed, quality production, get in touch with us. The anodic unit above is one of our many finishing units capable of a variety of mechanical, chemical finishes. All part of our mill-to-final-finish facilities, at your service.

METAL MEN OF MANITOWOC WISCONSIN

MAKERS OF

MIRRO

THE FINEST ALUMINUM

MIRRO ALUMINUM COMPANY

(Formerly Aluminum Goods Manufacturing Company)

MANITOWOC, WISCONSIN

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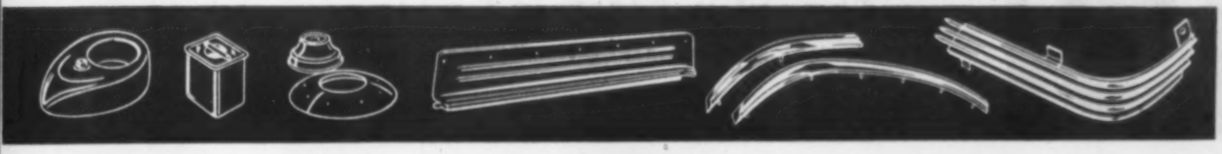
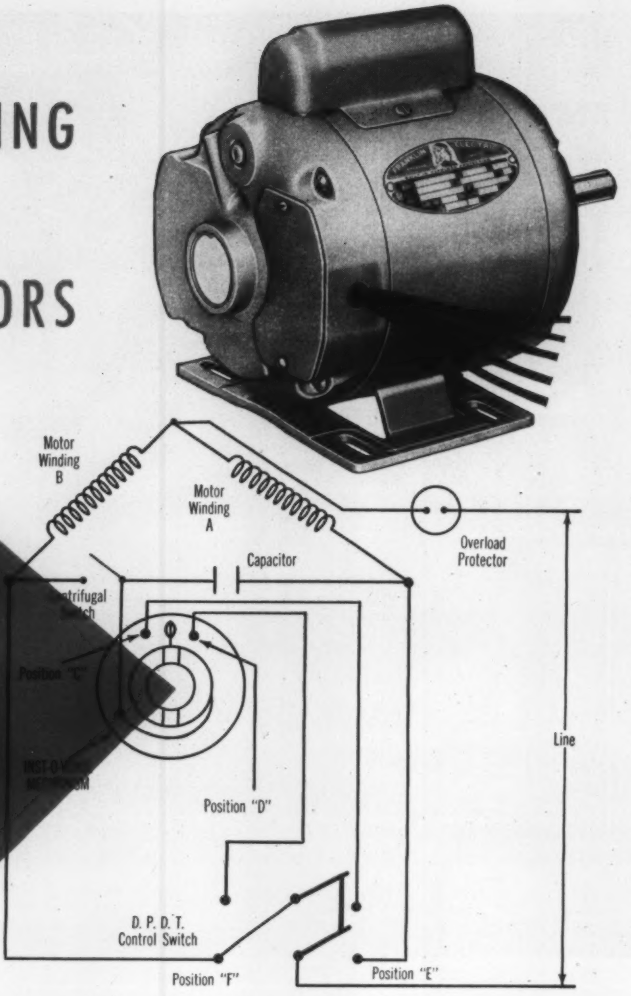


Franklin
INSTANT-REVERSING INST-O-VERSE MOTORS


Motor Winding B
Motor Winding A
Capacitor
Overload Protector
Centrifugal Switch
Position "C"
INST-O-VERSE MECHANISM
Position "D"
Line
D. P. D. T. Control Switch
Position "F"
Position "E"

PATENT-PROTECTED INST-O-VERSE® DEVICE

Control switch in "E" position . . . rotation is CW. Inst-O-Verse makes contact in "D" position due to shaft rotation. Motor operates as capacitor start, induction run with "B" as start winding.

Instant reversal occurs when control switch is thrown to "F" position as the Inst-O-Verse device has provided a circuit, bypassing the open centrifugal switch.

Operates in either direction as capacitor-start motor or instantly reversing motor. Operation is independent of sequence of rotational operation.

INSTANTLY UTILIZES FULL TORQUE CAPACITY OF MOTOR FOR REVERSING ROTATION

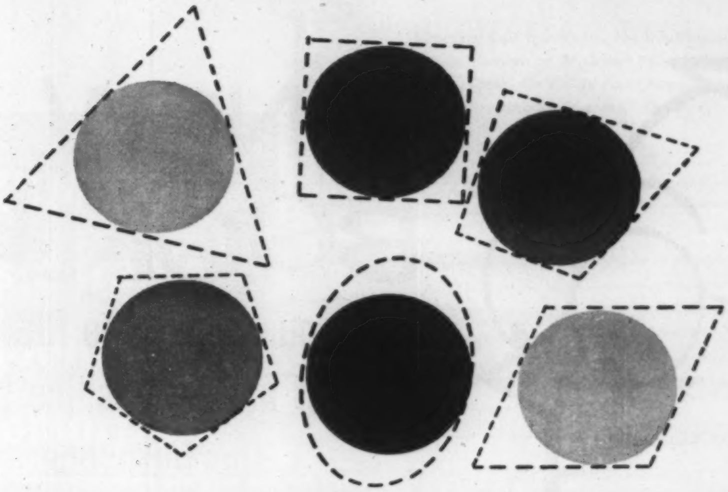
- AVAILABLE IN 1 PH., 1725 R.P.M., 115 OR 230 V., 1/6 THROUGH 1 H.P., SLEEVE OR BALL BEARING MOTORS.
- NEMA FRAME, OR APPLICATION-ENGINEERED MOUNTINGS.
- REVERSING ACTION OF 1-PHASE FRANKLIN INST-O-VERSE MOTORS IS EQUAL TO CONVENTIONAL THREE-PHASE REVERSING MOTORS.
- INST-O-VERSE ENABLES USE OF 1-PHASE INSTEAD OF 3-PHASE MOTORS FOR CUTTING COSTS.

Franklin Electric Co., Inc.

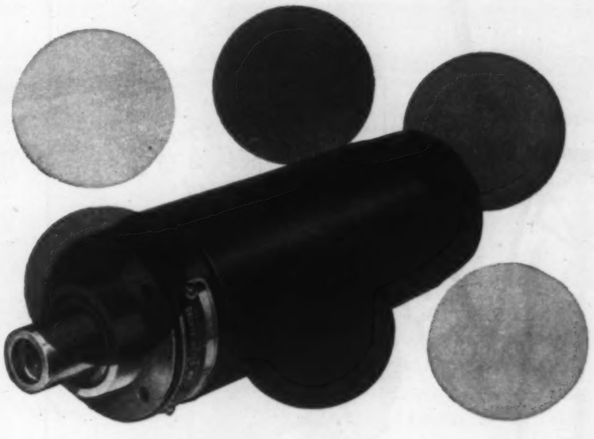
345 EAST SPRING STREET • BLUFFTON, INDIANA

Write for your copy of
"INST-O-VERSE MOTORS."

Franklin Electric
INST-O-VERSE



Air 150 psi
Hydraulic up to 1500 psi
Meet JIC Standards
Series 101A

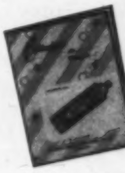


O-M Cylinders Fit Where Others Won't

THESE original space-saving O-M cylinders do more than fit into unusually close quarters too small to accommodate tie-rod cylinders of the same size bore. They save weight, improve appearance and assure smooth, dependable performance within a wide range of operating pressures. In addition, they are readily modified to serve in special applications, requiring semi-standard cylinders. And, the O-M Internal Locking Key, that makes it possible to orient the ports to any position, simplifies disassembly, inspection and service, eliminating alignment problems upon assembly. Completely interchangeable mounts and parts.

Available in 1½" to 8" bores with standard or heavy-duty piston rods.

Mail coupon today for 28-page Bulletin 101A replete with engineering drawings of cylinders, mounts, mounting brackets, capacity chart, and other performance data.



ORTMAN-MILLER MACHINE CO.
7 143rd Street, Hammond, Indiana

■ **Have representative call**
■ **Send Bulletin 101A**

NAME____________________ POSITION__________

COMPANY____________________

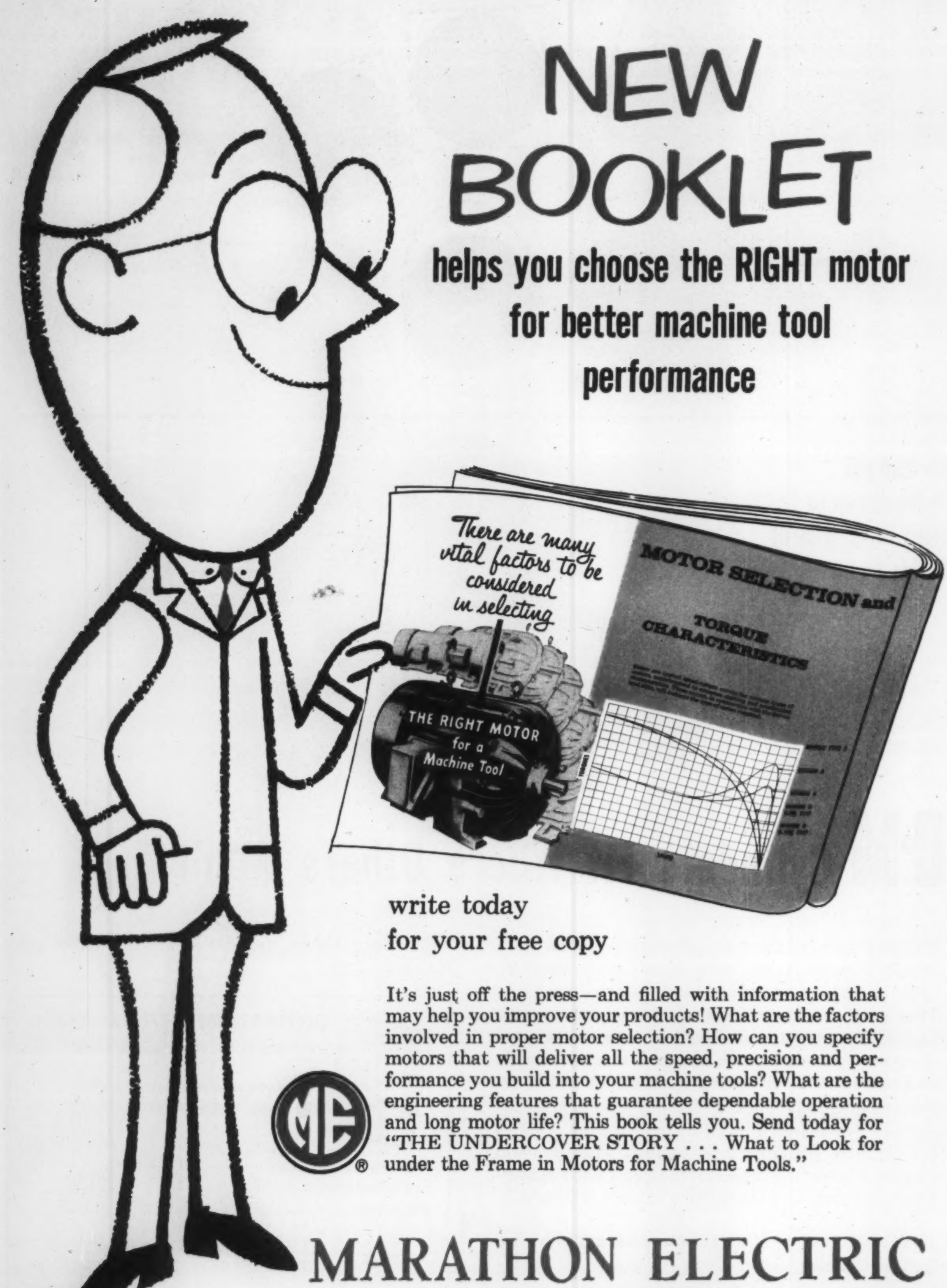
ADDRESS____________________

CITY____________ ZONE________ STATE________

Circle 438 on Page 19

NEW BOOKLET

helps you choose the RIGHT motor for better machine tool performance


There are many vital factors to be considered in selecting
THE RIGHT MOTOR for a Machine Tool
MOTOR SELECTION and TORQUE CHARACTERISTICS

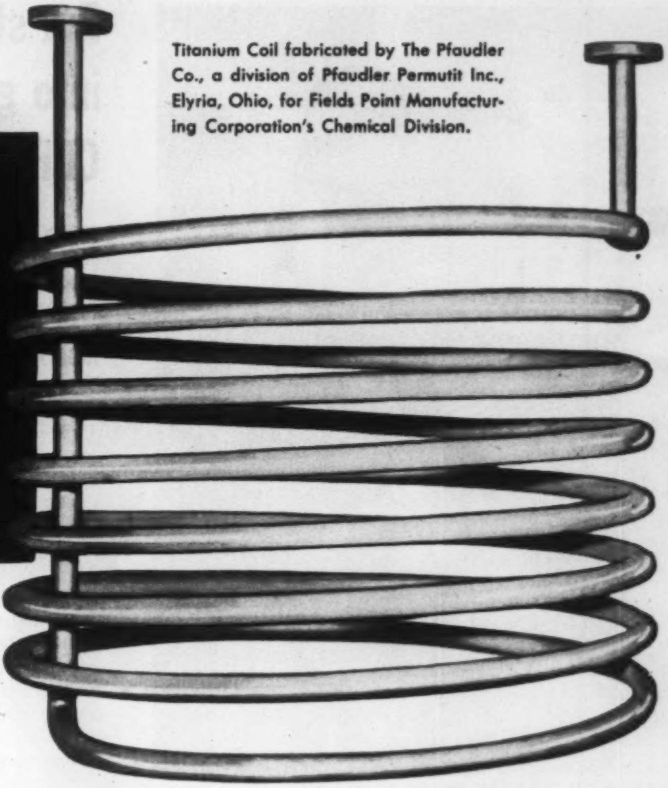
write today
for your free copy

It's just off the press—and filled with information that may help you improve your products! What are the factors involved in proper motor selection? How can you specify motors that will deliver all the speed, precision and performance you build into your machine tools? What are the engineering features that guarantee dependable operation and long motor life? This book tells you. Send today for "THE UNDERCOVER STORY . . . What to Look for under the Frame in Motors for Machine Tools."

MARATHON ELECTRIC

MARATHON ELECTRIC MANUFACTURING CORPORATION
Wausau, Wisconsin

TITANIUM COIL proves durable in sodium hypochlorite



Titanium Coil fabricated by The Pfaudler Co., a division of Pfaudler Permutit Inc., Elyria, Ohio, for Fields Point Manufacturing Corporation's Chemical Division.

expected to outlast silver... initial cost is less

The corrosive action of chlorine gas bubbling through a sodium hypochlorite solution meant replacement of cooling coils regularly. Even silver pipe lasted only about 2,500 batches.

Experiments with titanium were encouraging and after 6 months' exposure under operating conditions there was no detectable deterioration.

The first coil fabricated from Damascus titanium 2″ O.D. x 16 ga. tubing was installed and is now in service. Fields Point Manufacturing Company anticipates a service life of at least 5,000 to 10,000 batches. And the purchase of additional titanium coils is being considered.

Titanium being stronger than silver, a lighter gauge tube could be employed. Since fewer pounds of material were required, this meant the initial cost of the titanium coil was less than one made from silver.

For general corrosive service, Damascus offers stainless steel pipe and tubing in a full range of A.I.S.I. standard analyses but, where unusual corrosive service is encountered, can furnish exotic metals and special alloy grades.

COMPLETE INFORMATION ON RARE AND REACTIVE METALS PIPE AND TUBING

New 44-page handbook contains data on applications, heat treatment, corrosion resistance, chemical and physical analysis, mechanical properties of Zirconium, Zircaloy 2, Zircaloy 3; Titanium, grades 40, 55, and 70; Precipitation Hardening Steels, A-286, 17-7-PH, 15-7-MO; HASTELLOY ALLOYS, A, B, C, F, and X.

Reactive Metals and Super Alloys Handbook for Pipe and Tubing

DAMASCUS TUBE COMPANY
Greenville, Pa.

Gentlemen: Please send me your new 44-page handbook.

NAME__________

COMPANY__________

ADDRESS__________

CITY__________ ZONE_____ STATE______

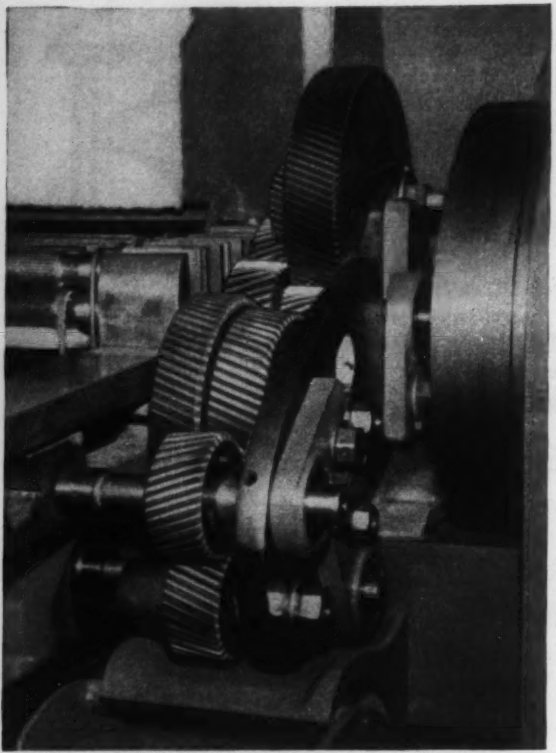
FORMED STEEL TUBE INSTITUTE

AMERICAN STEEL WAREHOUSE ASS'N

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA



CELORON-TO-CELORON GEARS in drawing rolls made by Ideal Industries, Inc., Bessemer City, N. C. These are helical-cut gears—the toughest to machine, requiring the toughest material. Celoron is it. Other Celoron parts for this application are shown below, top right.

Put strength, long life, silence into gears and couplings with CDF Celoron® molded plastics

WORK MIRACLES IN MACHINERY with this amazing golden phenolic material! Celoron gears help eliminate noise and reduce wear on mating metal gears. Even the roughest-used helicals last . . . and last . . . and last.

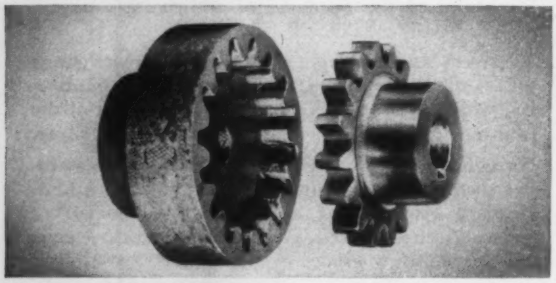
HIGH MECHANICAL STRENGTH. Typical Celoron strengths: tensile, 6,500 psi; flexural, 10,000 psi; compressive, 25,000 psi; shear, 8,500 psi. Dimensionally stable and readily machined, Celoron fills the bill where costly metal parts fail.

ELECTRICAL INSULATION VALUE. Celoron is a non-conductor with high electrical insulation value. It makes ideal mechanical-electrical parts. Celoron couplings effectively insulate motors from driven machinery.

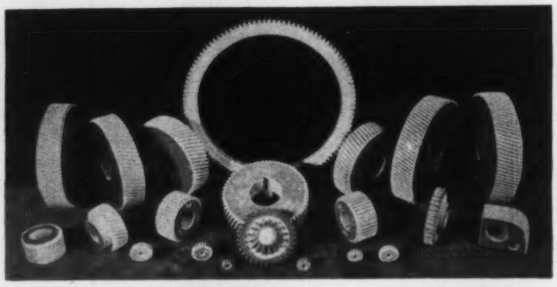
CDF FABRICATION SERVICE. Let the plastics-fabrication and molding experience of CDF save you time and money, and assure you delivery of production quantities of CDF plastics and molded parts—on time and as specified. The CDF man can help you from the very beginning. See his phone number in the Product Design File (Sweet's). Or send us your print or your problem, and we'll return samples and technical literature for your evaluation.

CONTINENTAL-DIAMOND FIBRE

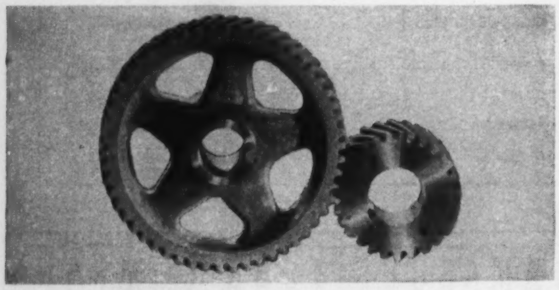
A SUBSIDIARY OF THE *Budd* COMPANY • NEWARK 23, DEL.



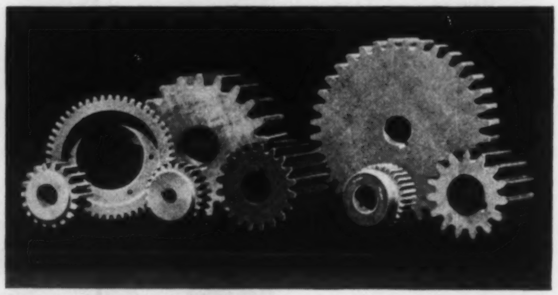
LOW-COST, EASILY-ASSEMBLED CDF Celoron flexible coupling transmits power smoothly, silently . . . insulates motor from machine . . . needs no lubrication . . . works vertically or horizontally.



PRECISELY MACHINED KEYWAYS help keep these Celoron parts silent and strong in the Ideal drawing rolls illustrated in top photograph. Note wide range of sizes and shapes.



CELORON-TO-STEEL combination makes this long-wearing timing mechanism for gasoline engines. Celoron gear absorbs shock, cuts sound to a minimum, holds timing longer.



STRONG, SILENT CELORON makes both drive and driven gears. In fact, many machine applications are 100% Celoron geared for light weight, elimination of excess play, long life.

High Stability

OHMITE®

RITEOHM® PRECISION Metal Film Resistors

A new kind of precision resistor with these important features

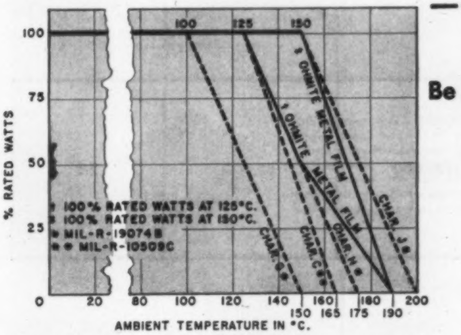
- Long-term load and shelf stability
- Low temperature coefficient of resistance
- Low noise level
- 125°C and 150°C ambient ratings
- Exceeds military specifications
- Excellent high frequency characteristics

Developed to meet tough new military and industrial demands, Ohmite Metal Film Resistors represent a radical departure in construction from wire-wound precision resistors. They employ no wire for the resistance element, yet feature stability and noise level comparable to wire-wound units. In addition, they have a low temperature coefficient of resistance, and excellent high frequency characteristics. Thus they are ideal for high-gain electronic circuits.

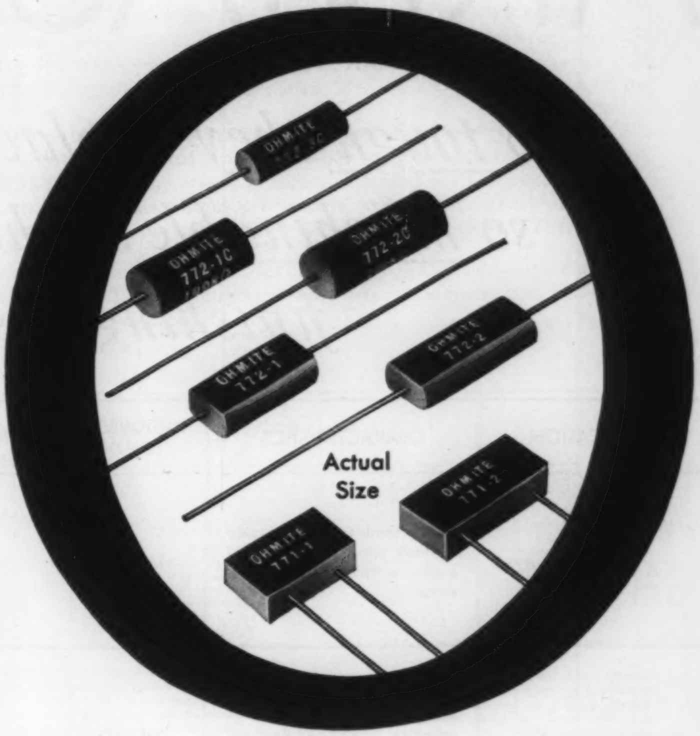
The expanded line of Ohmite Metal Film Resistors now consists of 5 sizes, and a total of 3 styles—full cylindrical, semi-cylindrical, and rectangular. With the new and existing sizes, Ohmite can now supply metal film units to meet various styles of MIL-R-10509C and MIL-R-19074B (Ships).

These new Metal Film Resistors may be used at full rated wattage in higher ambients than other types of precision film resistors. Wattage ratings range from ⅛ watt to 1 watt, depending on the resistor size and the ambient temperature. Ratings are based on two ambients—125°C and 150°C.

Temperature Coefficient of Resistance: Standard temperature coefficient is 0 ± 25ppm/°C (0 ± .0025%/°C) over a wide temperature range of −55°C to +190°C (25°C reference ambient) regardless of resistance value! Temperature coefficients of 0 ± 50 ppm/°C and 0 ± 100 ppm/°C are also available at lower cost. A temperature coefficient spread of 30 ppm/°C can be supplied at additional cost.



Watt rating chart. These curves indicate percentage of rated wattage that can be applied at temperatures higher than 125°C and 150°C. However, at no time shall the applied voltage exceed the maximum for each style.



Write for Bulletin 155

Be Right with OHMITE® Quality Components

Ohmite Manufacturing Company
3618 Howard Street
Skokie, Illinois

RHEOSTATS RESISTORS RELAYS
TANTALUM CAPACITORS TAP SWITCHES
VARIABLE TRANSFORMERS R. F. CHOKES
GERMANIUM DIODES

Circle 442 on Page 19

Castings of

ARMASTEEL®

so tough they replace forgings
so machinable . . . they reduce
finishing costs

CLASSIFICATION	CHARACTERISTICS	HARDNESS (BHN)	MIN. TENSILE STRENGTH (PSI)	MIN. YIELD STRENGTH (PSI)	MIN. % ELONGATION IN 2 INCHES
ARMASTEEL GM 86M	Recommended for less highly stressed parts. Replaces steel parts in 1020-1035 S.A.E. range.	163-207	70,000	48,000	4.0
ARMASTEEL GM 85M	Recommended for moderate strength plus adaptability to selective hardening. Replaces parts in 1035-1050 S.A.E. range.	197-241	80,000	60,000	3.0
ARMASTEEL GM 84M	Recommended for high degree of strength. Replaces heat-treated parts in 1040-1050 S.A.E. range.	241-269	100,000	80,000	2.0
ARMASTEEL GM 88M	High resistance to wear and high yield strength, yet retains machinability. Requires no heat-treating and possesses same strength and wear characteristics as alloy steel forgings.	269-302	105,000	85,000	2.0

CENTRAL FOUNDRY DIVISION GENERAL MOTORS CORPORATION

CENTRAL FOUNDRY DIVISION

Because ARMASTEEL castings are so machinable, so resistant to wear and shock, and so adaptable to selective hardening, they are rapidly replacing many parts formerly machined from bar stock or steel forgings.

ARMASTEEL, a pearlitic malleable iron, possesses the same strength and performance characteristics usually associated with plain carbon steel. In addition, ARMASTEEL contains excellent bearing properties, has high yield strength, good damping capacity, maximum rigidity and excellent fatigue life. Accurate control of heat-treating operations in the manufacture of ARMASTEEL produces a fine, uniform grain structure and provides excellent finishing qualities.

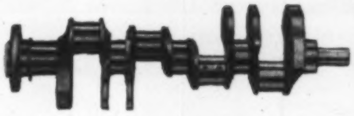
Four different types of ARMASTEEL can be cast to your specifications. One of the four (GM 84M, GM 85M, GM 86M or GM 88M) will have the physical properties to best meet the requirements of your application. For example, ARMASTEEL castings are being successfully used in the automotive, appliance and implement fields for such parts as gears, pistons, crankshafts, rocker arms and universal joint yokes, all of which utilize to best advantage the outstanding characteristics of ARMASTEEL.

Some of these applications are shown in the table. Look them over carefully; you may find that these characteristics and advantages of ARMASTEEL can help reduce your costs . . . increase your production . . . and improve the performance of your products.

Typical ARMASTEEL castings

Because of the greater physical properties of GM 86M ARMASTEEL, it was possible to redesign this anchor plate as shown and effect a weight reduction from 2.26# per piece to 1.44# per piece.

GM 86M ARMASTEEL provides the ideal casting for this automobile differential case because of its high strength, minimum deflection and good damping qualities which contribute to quietness of operation. Note the as-cast internal cavity and the well-formed webs.

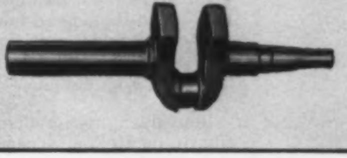


GM 85M ARMASTEEL provides a crankshaft with more desirable machining characteristics than a forged crankshaft of SAE 1045 steel. Improves machining of journals and reduces cheeking stock. Use of GM 85M ARMASTEEL made possible the redesign of the crankshaft with a resulting 3.5# weight reduction and a lower material cost.

By converting to GM 85M ARMASTEEL, drilling and boring operations were eliminated on this crankshaft sprocket. Stock in rough part was reduced from 1.93# in forging to 1.00# in casting. Customer realized reduced piece price with GM 85M ARMASTEEL.

GM 84M ARMASTEEL was specified for this socket plate journal because its microstructure makes it more easily machined than steel with the same physical properties. It has better bearing and wear resistance qualities . . . less distortion during machining . . . and does not require heat treatment. Weight of part in rough is less than comparable steel forging.

Crankshaft for newly designed small gasoline engine. GM 84M ARMASTEEL specified because of outstanding success in similar engines. Less stock removal and better machinability are advantages over forged crankshaft.



This planet gear carrier was formerly forged from SAE 1141 steel, which required a heat treatment after rough machining and broaching operations. By converting to GM 88M ARMASTEEL, heat treatment was eliminated and the weight of the rough part was reduced.

By converting to GM 88M ARMASTEEL for this universal joint yoke, hole thru hub could be cast in . . . eliminating a drilling operation and reducing weight of part approximately 30%. GM 88M ARMASTEEL part has lower piece price than forging formerly used.

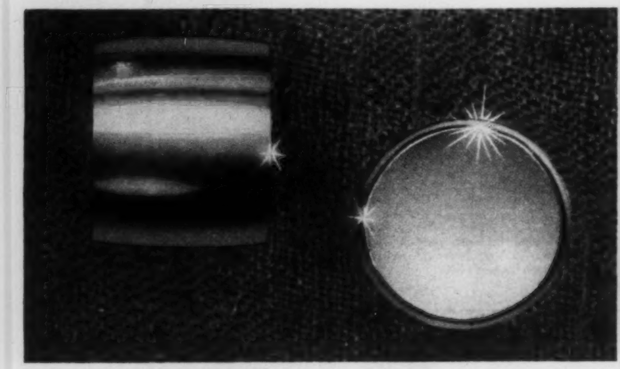
85

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 14

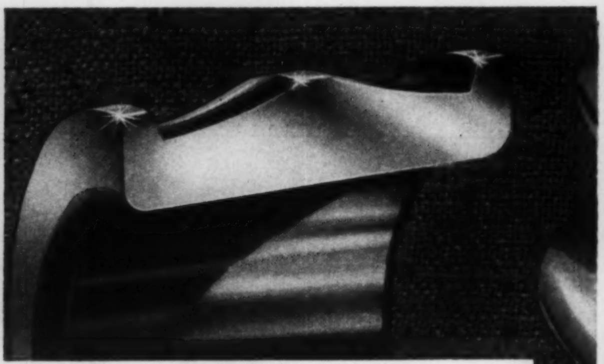
News! The best features of modern bearing design combined

Spherical

SELF-ALIGNING ROLLER BEARINGS BY LINK-BELT



BIG, HIGHEST-CAPACITY ROLLERS. Each bearing has a maximum number of rollers—as large as possible, yet all components are in optimum balance. Precision-ground to extreme accuracy, these convex rollers offer maximum economy for all applications.



HIGH, HEAVY INNER RACE FLANGES. Hefty inner race has sturdy shoulders which offer convenient hold for assembly and removal of bearing. They end problems of cutting away shaft or applying pressure at outer race . . . avoid any need to skimp on shaft shoulders.

Big, mirror-smooth convex rollers *plus* heavy, broad-shouldered inner race *plus* centrifugally-cast bronze, precision-machined retainer! Only from Link-Belt do you get ALL that is best in bearing design.

Individually, these elements represent major improvements on accepted design concepts. Collectively, they constitute the most efficient spherical roller bearings available . . . promise unequalled economies, whatever the application. Men who know bearings will readily recognize new contributions to capacity, endurance and ease of maintenance.

For the good of your equipment, take time for a feature-by-feature comparison with any bearings you're now using. Your Link-Belt office will gladly explain the many performance advantages evolved with this new design. It can furnish full data on industry's most complete line of ball and roller bearings . . . pillow blocks and flanged, flanged cartridge, cartridge and take-up blocks.

LINK-BELT

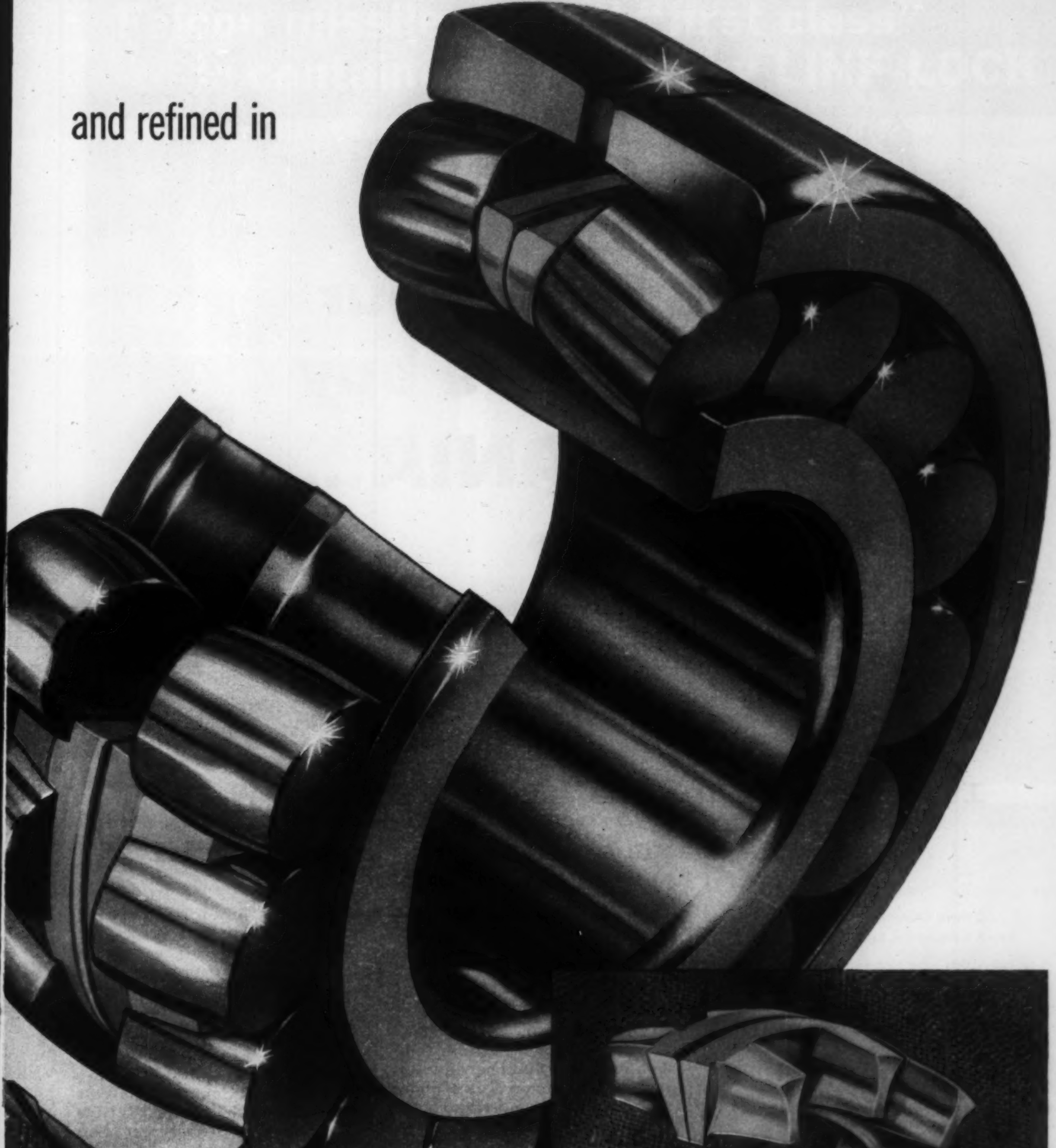
THE SYMBOL OF QUALITY LB LINK-BELT

MANUFACTURER OF SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Brazil, Sao Paulo; Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

14,818-A

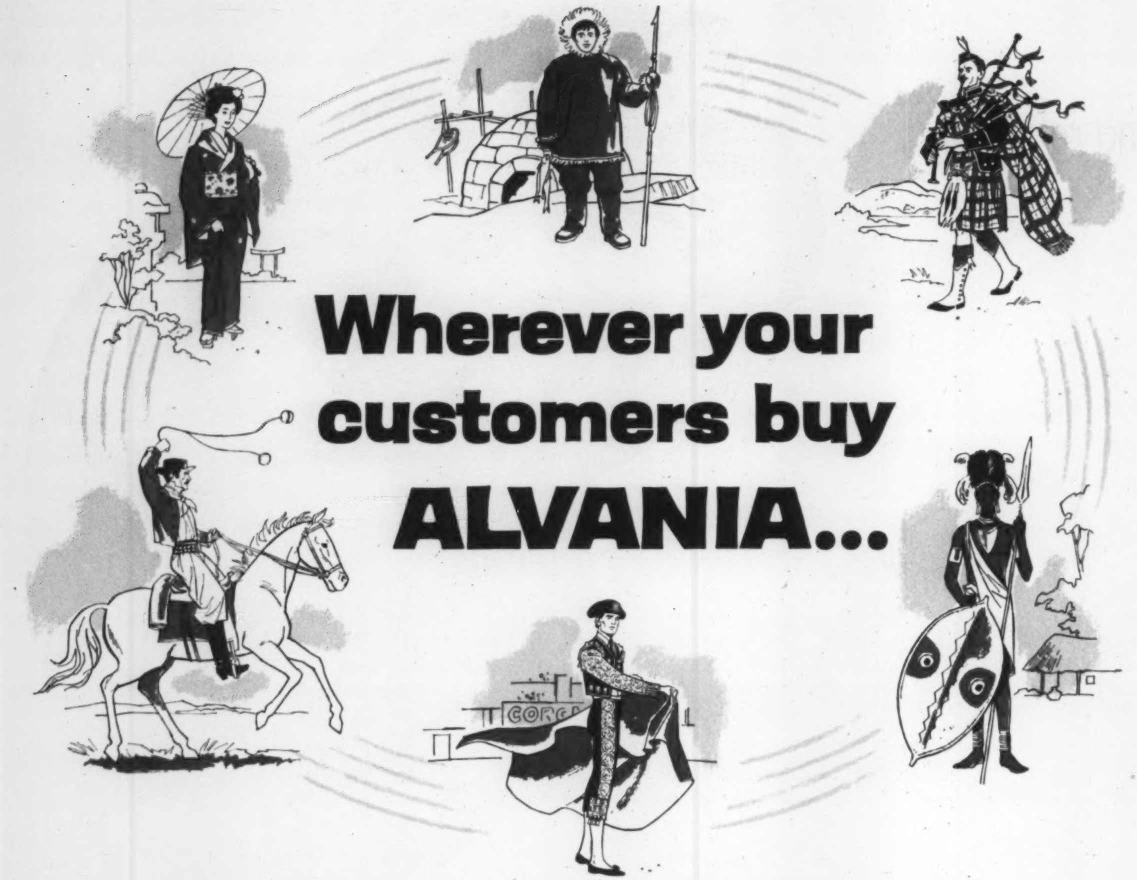
and refined in



See our exhibit, Design Engineering Conference, Convention Hall, Philadelphia, May 25-28, Booths 436-438.

PRECISION-MACHINED, CENTRIFUGALLY-CAST BRONZE RETAINERS offer many times more support and ability to withstand high stress. They are not stampings—they space rollers accurately under extreme speeds and loads. Independent cage action for each row of rollers assures maximum bearing efficiency.

Circle 444 on Page 19



Wherever your customers buy ALVANIA...

Its performance and name are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for hydraulic systems

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Rimula Oils—for heavy-duty diesel engines

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

SHELL ALVANIA GREASE is available world-wide . . . assurance that your customers abroad will get the same performance from your equipment that domestic customers rely upon.

You can count on Alvania® Grease to remain plastic in subzero weather and, equally important, to remain stable under sustained high temperatures. On job after job, Shell Alvania Grease has successfully replaced dozens of special lubricants.

Alvania Grease also has an outstanding performance record on the toughest anti-friction bearing grease applications. It is ideal for wet, humid applications because it is inhibited to prevent water corrosion. It gives good lubrication under conditions which normally spell trouble.

For complete information on this truly multi-purpose grease, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco, 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

SHELL

SHELL ALVANIA GREASE

the truly multi-purpose lubricant

Falcon missiles travel "first class" in containers secured by LINK-LOCK

Fourteen No. 2 LINK-LOCK fasteners → maintain a pressure-tight seal around cover of Falcon cases.

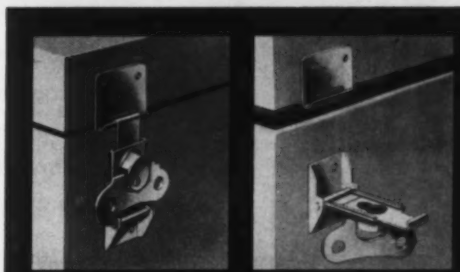
Before they take to the skies, Falcon air-to-air guided missiles are shipped or stored in containers sealed pressure-tight by Simmons LINK-LOCK fasteners.

These precisely engineered fabricated aluminum cases are produced to Hughes Aircraft Company specifications by the following companies: Vendorlator Manufacturing Co., Fresno, California; Allison Steel Manufacturing Co., Phoenix, Arizona; Avco Corporation, Crosley Division, Richmond, Indiana.

Features like these make the LINK-LOCK ideal for use on military cases made to rigid specifications as well as on inexpensive commercial containers:

- Impact and drop resistant.
- Positive-locking without springs.
- High preloading and high load carrying capacity.
- Compact design—lies flat open or secured.
- 3 sizes, for heavy, medium, light duty.
- Flexible engagement latch design... can be varied to suit different applications.

Write for Catalog #1257. Contains complete details of LINK-LOCK and other Simmons Fasteners with unlimited money-saving applications. Samples and engineering service available on request.

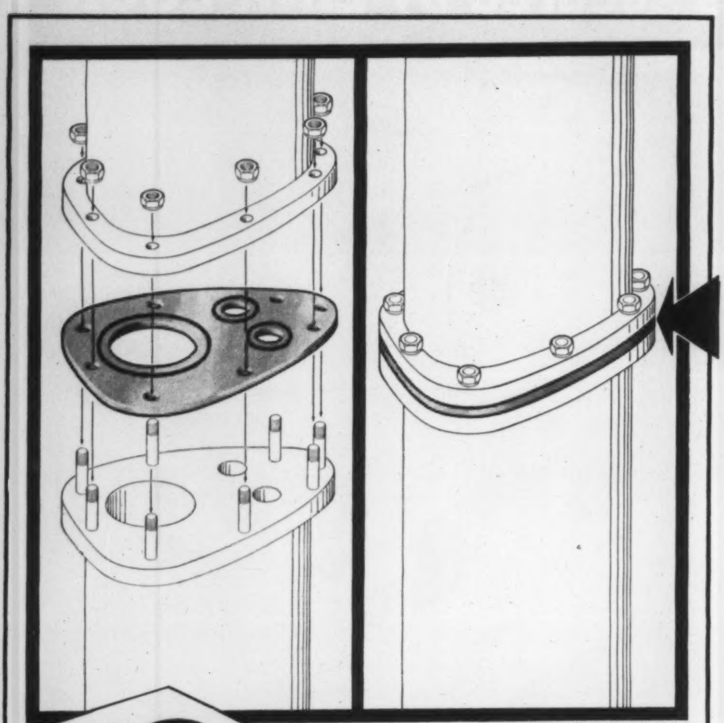


Half-turn applies high closing pressure, counter-turn disengages for opening. LINK-LOCK lies flat open or closed.

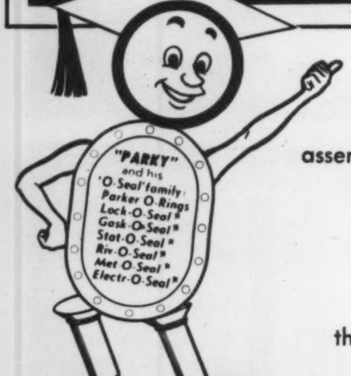
SIMMONS
FASTENER CORPORATION
North Broadway, Albany 1, New York
QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK
DUAL-LOCK • HINGE-LOCK
See our 8-page catalog in Sweet's Product Design File

VISIT US AT BOOTH 325, 1959 DESIGN ENGINEERING SHOW, Philadelphia, May 25-28

DO YOU KNOW ABOUT GASK-O-SEALS?

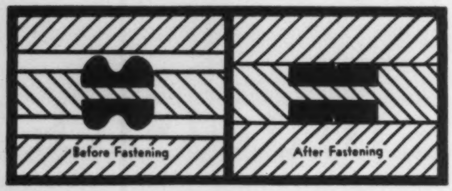


You Can't leave a Gask-O-Seal® out!


"PARKY"
and his
'O-Seal' family:
Parker O-Rings
Lock-O-Seal®
Gask-O-Seal®
Stat-O-Seal®
Riv-O-Seal®
Met-O-Seal®
Electr-O-Seal®

Hundreds of accidents have been caused by seals being left out during assembly or repair, and thousands of production hours have also been lost for the same reason. Just one of the plus values of Gask-O-Seals is that they are practically impossible to leave out because they are inspectable visually after assembly. This can mean many valuable warranty dollars saved, many hours of downtime saved — and it may mean the saving of human lives.

They also provide no-leakage positive sealing, prevent blow-outs. Damaging coldflow is eliminated, high manufacturing and maintenance machining costs are avoided and they are reuseable. If you use static seals in your designs, why not find out about Gask-O-Seals — made by the makers of Parker O-rings.


Before Fastening
After Fastening

Parker SEAL COMPANY

CULVER CITY, CALIFORNIA and CLEVELAND, OHIO
A DIVISION OF PARKER-HANNIFIN CORPORATION

L900 SERIES MEDIUM DUTY

Faultless Casters

NOELTING
FAULTLESS
Load Capacities in a New Dimension

APPLICATIONS

BAKERIES—Bread Racks—Dish Trucks—Pan Racks
BANKS—Money Trucks—Portable Files
CAFETERIAS—Dish Trucks
CHAIN & DEPARTMENT STORES—Dollies—Stock Trucks
FOUNDRIES—Core Trucks
GARAGES—Dollies
HOSIERY MILLS—Stock Trucks—Yarn Trucks
HOSPITALS & HOTELS—Linen Trucks
INDUSTRIAL PLANTS—Assembly Lines
PACKING PLANTS—Curing Racks
PRINTERS—Type Trucks
WAREHOUSES—Stock Trucks

NOELTING
Faultless
Casters

SUPERIOR DESIGN FEATURES

1. **CORRUGATED TOP PLATE** . . . fully hardened to give added strength. Slotted mounting hole spacing permits easy attachment to new equipment. Fits holes drilled from centers of 2⅝" x 3⅝" to 3" x 3" when used as replacement casters.
2. **MAIN LOAD BEARING** . . . consists of 21 hardened, polished balls (⅜" dia.) rolling in large dia. hardened, lubricated raceway permanently attached to caster horn to assure perfect alignment.
3. **LOWER THRUST BEARING** . . . contains 10 hardened steel balls (5/16" dia.). Hardened raceway is machined from bar stock. Ball retainer is hardened formed steel.
4. **EXTRA-LARGE DIAMETER KINGPIN** . . . assures bonus strength in this caster, and strong, trouble-free construction.
5. **CLOSE FITTING, FORMED STEEL CUP** . . . protects thrust bearing from dirt, water and other foreign matter. Holds lubricants in bearings, keeps floor clean.
6. **HEAVY GAUGE, FORMED STEEL HORN** . . . easily absorbs highest rated loads and thrust. Correct offset permits easy swiveling and shimmy-free running.
7. **FULL SELECTION OF WHEELS** . . . for all types of floors and operating conditions. Bolt and nut axles permit quick wheel replacement when needed.

SERIES L9700 RIGID PLATE CASTER

Wheel types and sizes, load capacities and overall heights to match L900 Swivel Plate Caster.

ASK YOUR DISTRIBUTOR!

Your nearby Faultless Industrial Distributor maintains a substantial inventory of Faultless Casters for immediate delivery. He and one of the strategically located Faultless Sales Engineers are available to work with you on every handling problem in your plant. Both are listed in phone book Yellow Pages, under "Casters," beneath the Faultless heading.

FREE! SEND FOR ILLUSTRATED LITERATURE

Faultless Caster Corporation
Evansville 7, Indiana

Send me Free L900 Medium Duty Caster information.

Name____________________

Firm____________________

Address____________________

City____________________State__________

Circle 448 on Page 19

NEW! "feather-touch" PUSH-to-TEST PILOT LIGHT

- Completely oil-tight, even when depressed
- Pressure connections eliminate internal wires
- Positive contact "feel" in test position
- No additional panel space required
- Choice of 6 color caps
- Full range of voltage ratings
- Mounts interchangeably with oil-tight pushbuttons and selector switches

Here's Why Square D Pushbuttons are preferred —by those who *build* machines—and by those who *buy* them

Easy to use • Square D oil-tight pushbutton operators require only a single mounting hole. Contact block terminals have pressure wire connectors for simplified wiring.

Longer lasting • Operators have all-metal construction, with anodized aluminum buttons for greater mechanical life. Melamine contact blocks with double-break silver contacts assure longer electrical life.

Wide flexibility • Any operator can be used with any contact block to meet all your requirements. Pushbuttons, selector switches, and pilot lights mount interchangeably.

Small size • Square D oil-tight pushbuttons require only a minimum of panel and back-of-panel space—and they can be mounted in any position.

Variety of contacts • Contact block arrangements include single-pole double-circuit, duplex double-circuit, tandem duplex, three-position duplex, and overlapping contacts.

• • •

FOR COMPLETE INFORMATION

on oil-tight pushbuttons, ask for Bulletin 9001-T —Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

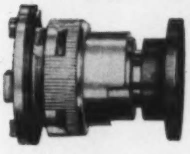
EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

LATEST ADDITION to SQUARE D LINE of Oil-Tight Pushbuttons

OIL-TIGHT OPERATORS

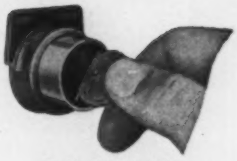
Standard Button



Mushroom Button

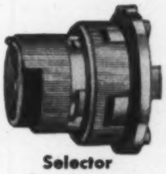
HAND
OFF
AUTO

Selector Switch

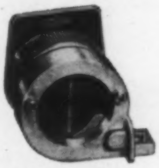


Coin-Operated Selector Switch

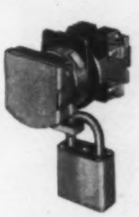
Key-Operated Selector Switch



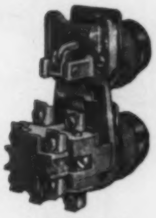
Selector Pushbutton



Stop Button Lockout



Start Button Lockout

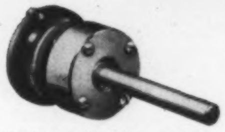


Maintained Contact Attachment

NEW!

Selector Switch and Pushbutton Lockout

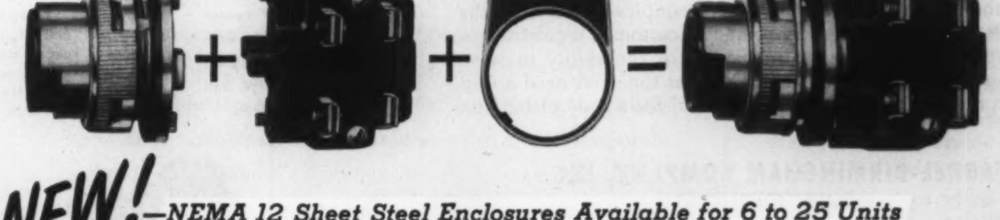
4-Position Joystick Operator



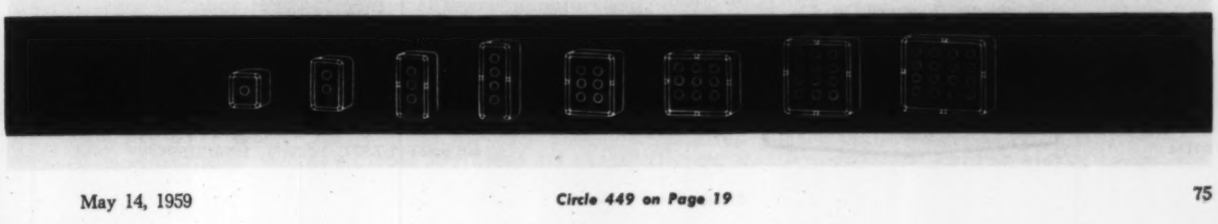
Wobble Stick Operator

Neoprene Cap

ANY OPERATOR WITH ANY CONTACT BLOCK

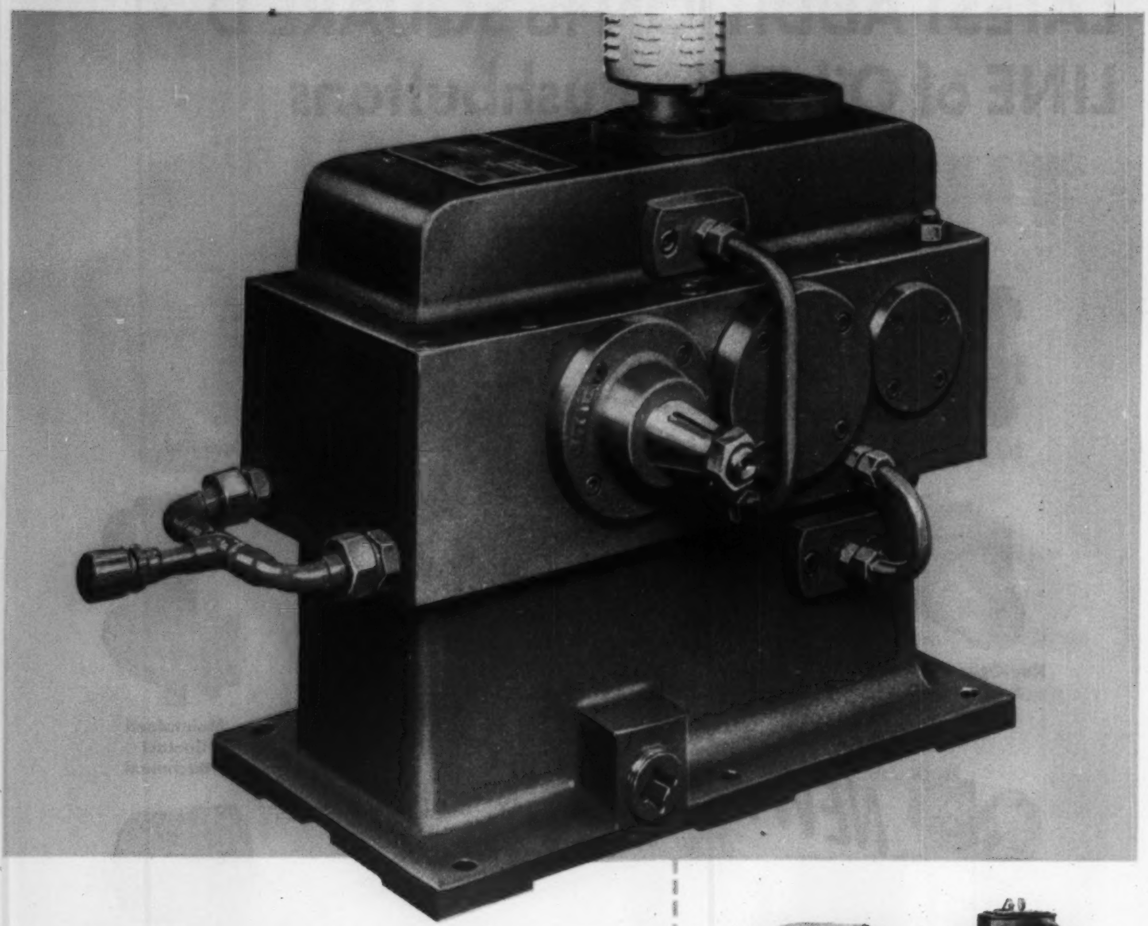


NEW! ***—NEMA 12 Sheet Steel Enclosures Available for 6 to 25 Units***
Cast Enclosures Available for 1 to 16 Units



Circle 449 on Page 19

100,000 RPM FOR A TEST STAND



Another example of Farrel's ability to meet extraordinary gearing requirements

The speed increaser shown above—built for operation at 100,000 rpm—is only one of the scores of highly specialized test-stand units designed and built by Farrel. Three other examples are shown at the right. Each was individually engineered to customer requirements.

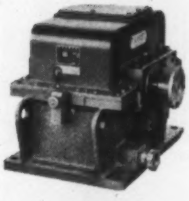
This experience offers virtual assurance of the ability to solve your high-speed gearing problems. The next time you need a test-stand unit, call Farrel. In the meantime send for a copy of bulletin 451.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

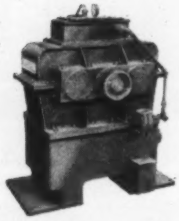
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Fayetteville (N. C.)
European Office: Piazza della Repubblica 32, Milano, Italy

FARREL

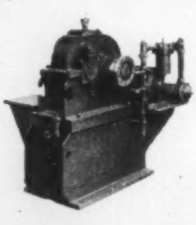
FB-1164



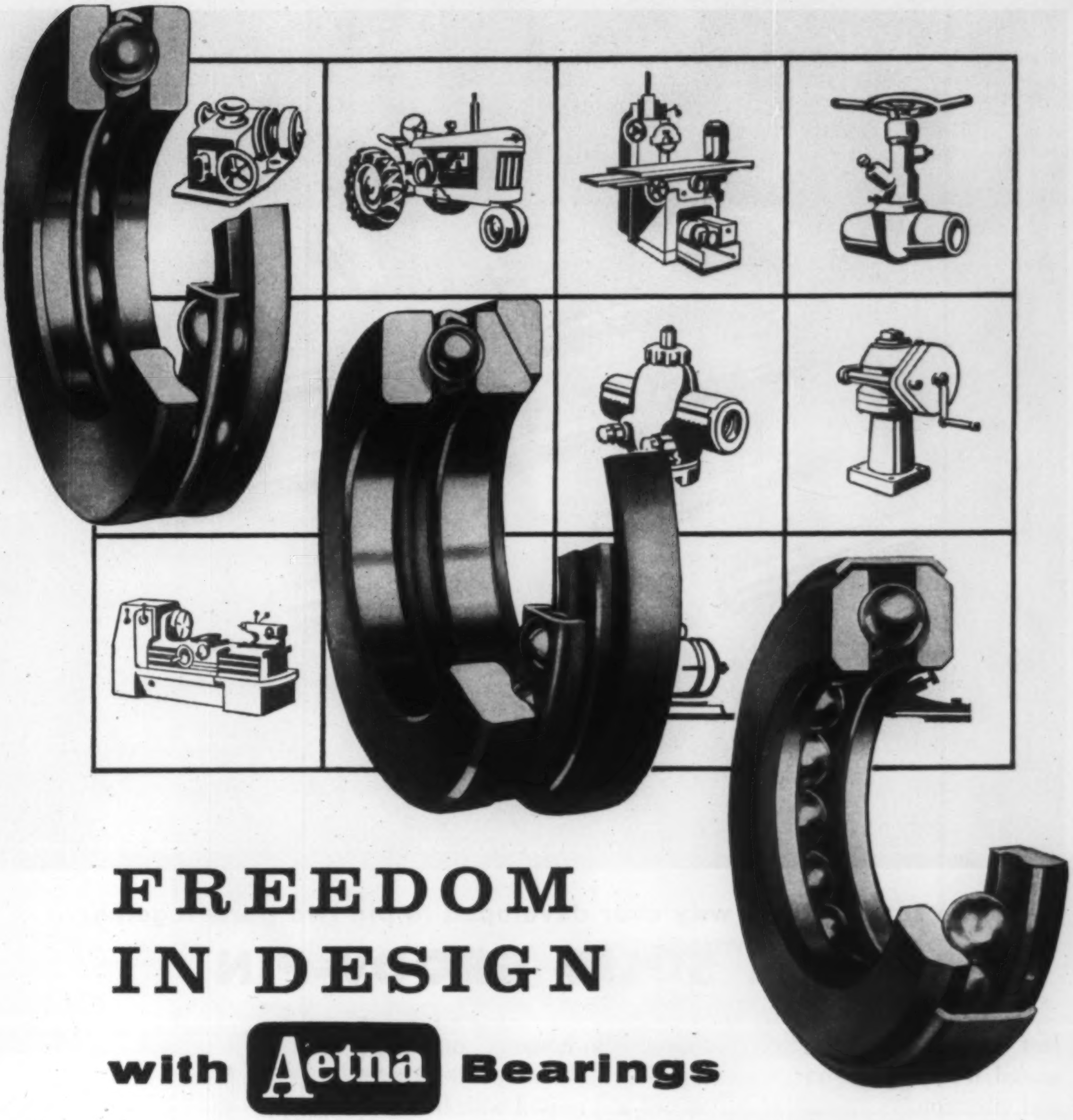
Special 375 HP speed-increasing unit, with two speed ranges, 6,000/10,769 RPM and 6,000/15,100 RPM.



Special DD-9 speed-increasing unit, 660 HP, input speed range from 1,500 to 3,000 RPM, output speed range from 20,000 to 40,000 RPM.



Special SI-825 speed-increasing unit, 150 HP, 3,000 to 5,000 input RPM, with 3 gear-set ratios—1:7.971, 1:2.5091, 1:1.0127.



FREEDOM IN DESIGN

with Aetna Bearings

Designers have learned that they can depend upon Aetna original thinking and creative engineering to provide greater freedom of design in meeting their anti-friction problems.

In the solution of difficult problems, Aetna's specialized knowledge and experience—combined with fresh viewpoints, ingenuity and a sincere desire to serve—have produced practical combinations or arrangements of an unusual nature which enabled designers to produce better operating, more simplified equipment at lower manufacturing costs.

CALL UPON AETNA WHEN you have equipment in the design stage which presents special bearing problems. Our experienced, creative engineering department will gladly work with you to produce the special bearings or precision parts which meet your design requirements.

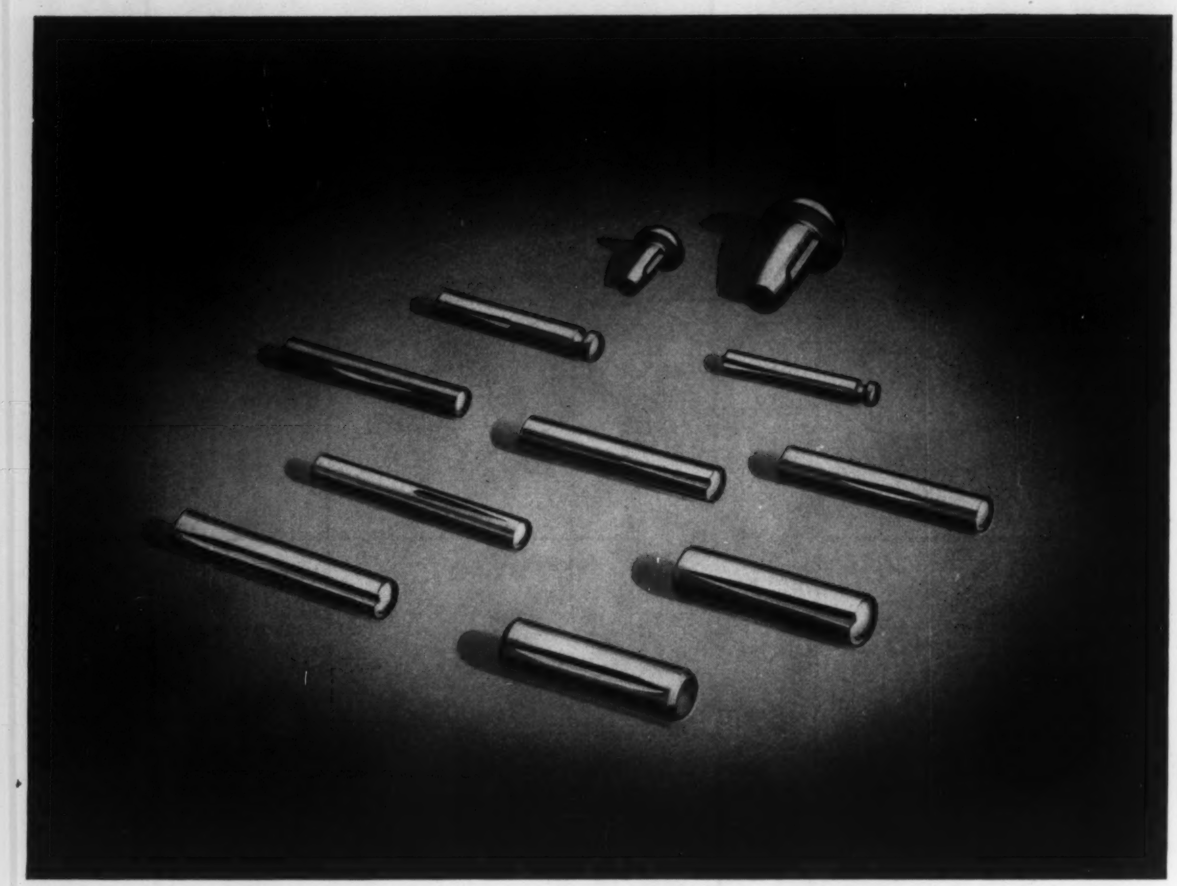
AETNA BALL AND ROLLER BEARING COMPANY

Aetna

DIVISION OF PARKERSBURG-AETNA CORPORATION • 4600 SCHUBERT AVE. • CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

Circle 451 on Page 19

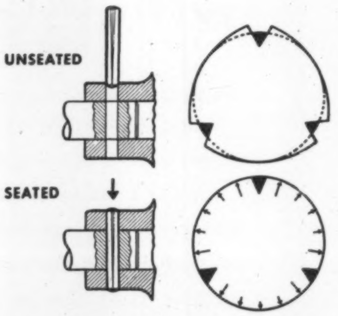


The surest, safest way ever developed to pin two parts together...

THE SOLID GROOV-PIN

Just drill the hole and drive the Groov-Pin home . . . once seated, it stays there, no matter what the conditions of shock and vibration. Yet it can be drifted out and reused with but little loss of its original holding power. No reaming is necessary. Available in nine different types, as well as in drive studs. Diameters from 1/32″ to 1/2″ and larger for special requirements, in a wide variety of materials. There's a Groov-Pin for every need, including the Type 3H for hopper feeding, and Types 6 and 7 for anchoring tension springs. Standard prices apply to specials in lots of 5000 or more.

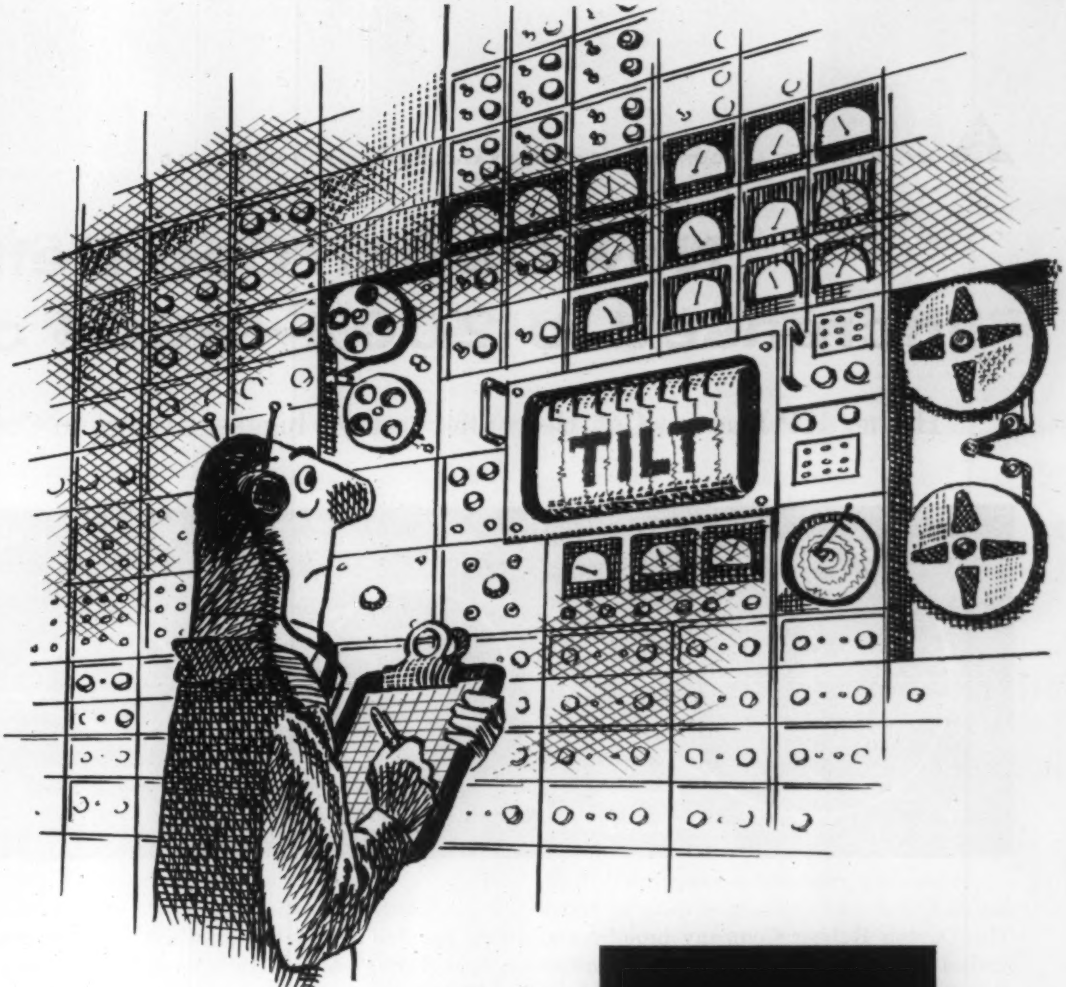
Write today for free samples and the new 32-page Groov-Pin catalog... yours for the asking, it belongs in every designer's file of fastener reference literature. Address Groov-Pin Corporation, 1130 Hendricks Causeway, Ridgefield, N. J.



The unique GROOV-PIN locking principle

When a Groov-Pin is driven, the material displaced by the grooves is forced to flow back, setting up a powerful locking force. The ability of Groov-Pin to hold under severe shock and vibration . . . and its immunity to vibration fatigue . . . has been thoroughly proved by the billions in use!

GROOV-PIN



A lot at stake?

Relay failures can be much more serious than interruption of data recording . . . they can involve a big monetary loss or even loss of life. That's why important equipment like Remington Rand Univac® systems depend on Adlake . . . the relays that are unaffected by dust, dirt, moisture or temperature changes. Hermetically sealed mercury-to-mercury contact is quiet, chatterless . . . can't burn, pit or stick. No. 1140, shown here, is but one of four basic models designed to your control needs. Send for free Adlake Catalog J-8905.

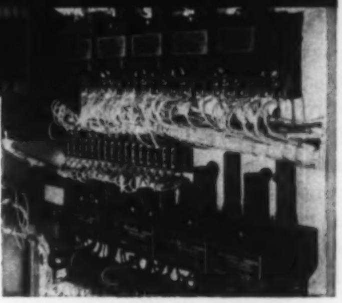
The Adams & Westlake Company, Elkhart, Ind. Adlake 103rd YEAR

See us at Booth 1536,
Design Engineering Show,
Philadelphia—May 25-28

Depend on

A+dlake

mercury relays
and controls

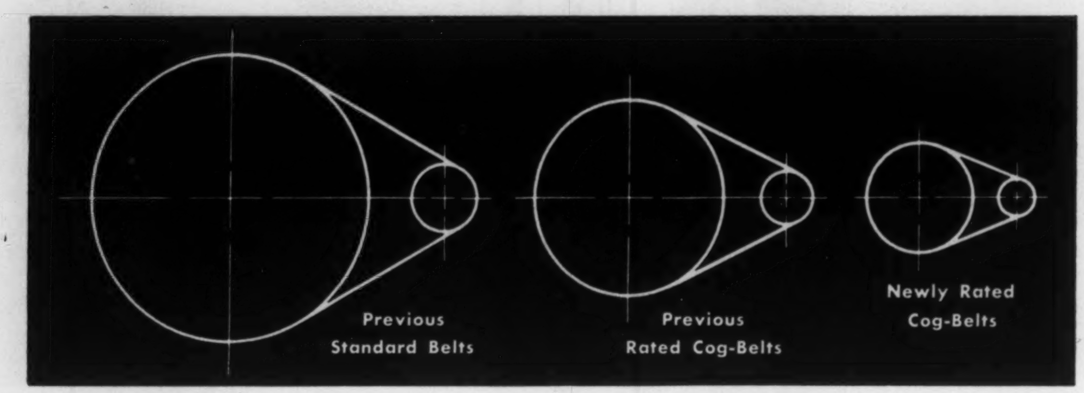


Section of Adlake relays used in the Remington Rand Univac® system at Miles Laboratories, Inc., makers of Alka-Seltzer®.

AN IMPORTANT ANNOUNCEMENT FROM HEADQUARTERS FOR **NEW** IDEAS

Now Dayton Cog-Belt® increased to 200%–300% of

Higher HP Dayton Cog-Belts offer today's biggest savings in Cost,



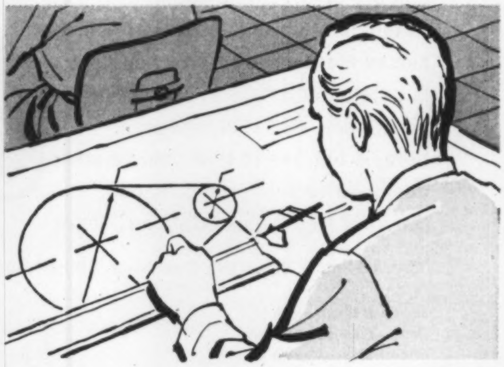
The Dayton Rubber Company proudly announces the findings of the most extensive, thorough analysis project in the V-Belt power transmission field, during which literally hundreds of thousands of V-Belt drives were evaluated by a renowned, independent engineering laboratory.

This long-term project was initiated because Dayton Cog-Belt performance had been noticeably upgraded over a period of years, through continued research and development in new materials and improved features . . . indicating that heretofore established HP ratings have become obsolete.

The result: Important new increases in Dayton Cog-Belt horsepower ratings . . . *now 2 to 3 times higher than previous standard V-Belt ratings.*

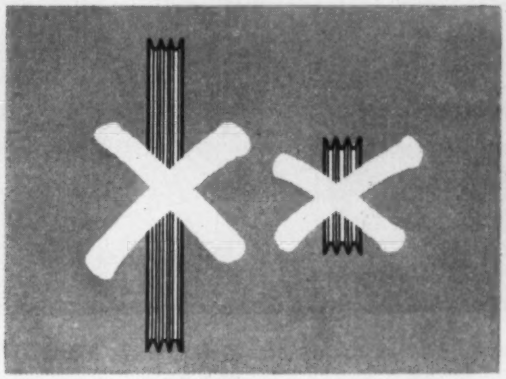
For the V-Belt drive designer . . . New Compactness, Lightness, Economy.

Dayton Cog-Belts, delivering 2 to 3 times more horsepower, permit drive designers to use narrower sheaves, less grooves, fewer belts for any V-Belt drive. *Two Cog-Belts do the work of 4 to 6 previous standard V-Belts.* Drive space thus saved permits new compactness of design, lighter weight and lower cost . . . job-proven on thousands of power drives throughout all industry. First costs and maintenance costs can be substantially reduced with Dayton Cog-Belt drives.

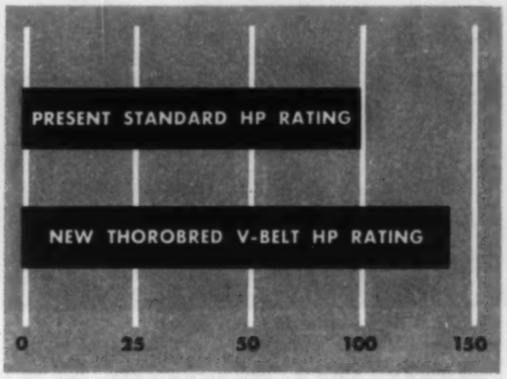


Horsepower Capacity previous Standard Belt Ratings

Drive Space, Weight . . . using *existing industry-standard sheaves.*



**No special sheaves required . . .
Existing sheave stocks usable.**



**HP Ratings on Dayton Thorobred
V-Belts also substantially increased.**

Using long-accepted industry-standard sheaves, *Dayton Cog-Belts do not obsolete present stocks of sheaves* . . . drives can be assembled from any existing inventories. Newly-rated Dayton Cog-Belts permit use of sheaves with smaller diameters and comparably closer centers . . . always at a savings in cost and weight. Because Dayton Cog-Belts operate on industry-standard sheaves, there is no need to stock additional special sizes. Present inventory stocks allow you to cover a greater range of higher horsepower capacities.

Dayton Thorobred V-Belts, through similarly evolved improvements in materials and research, are now also officially increased in horsepower capacity—40% more than previous standard ratings. Five Dayton Thorobreds now do the work of seven standard-rated V-Belts. Here again are important increases in power drive capabilities and cost reductions! With these new ratings, the Dayton Thorobred is unquestionably the leading performer of all standard-type industrial V-Belts.

Write for new brochure showing how designers can calculate Dayton Cog-Belt drives by referring to existing drive selection tables in Dayton's #280-B Handbook of V-Belt Drive Design. See "Belting" in the yellow pages of your telephone directory for the name of your nearest Dayton Distributor or write Dayton Industrial Products Company, Division of The Dayton Rubber Company, Dayton 1, Ohio.

***Utilize over 30 years of time proven Dayton quality,
research and engineering in your V-Belt drive design.***

Dayton Industrial Products Co.

A Division of The Dayton Rubber Company, Dayton 1, Ohio

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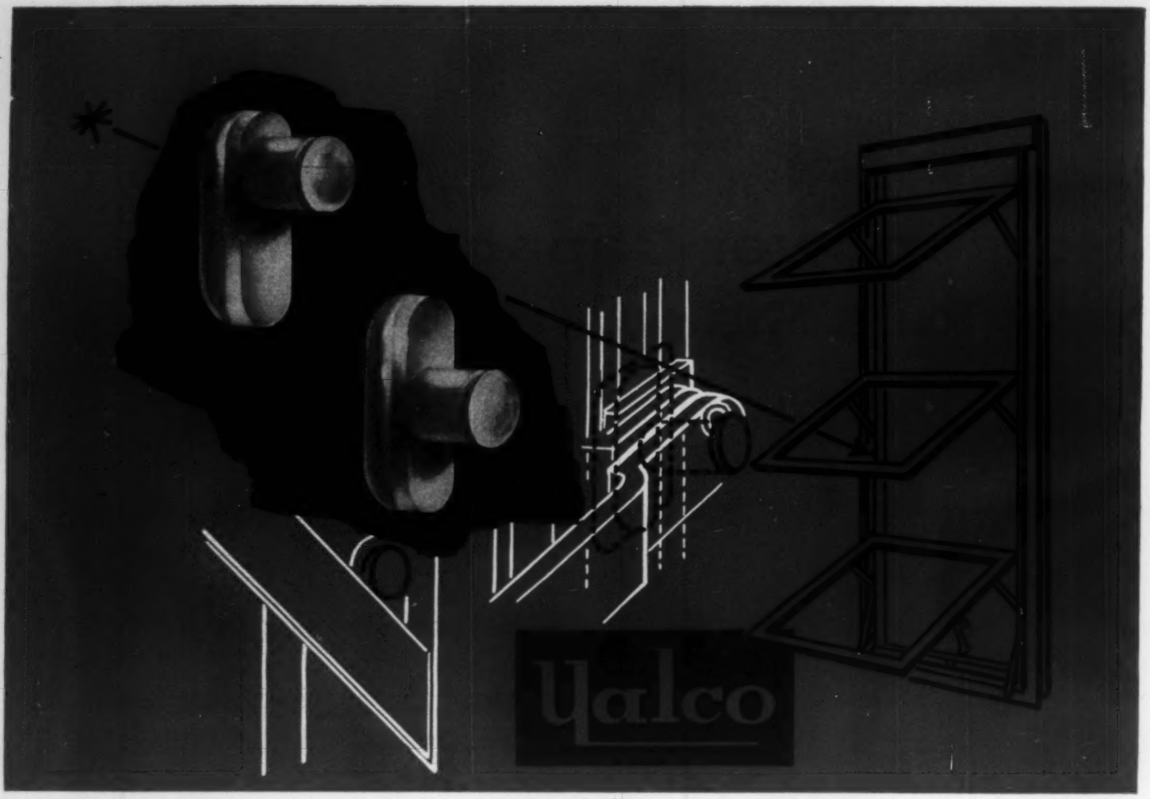

Molded Nylon Parts by . . .

QuinnBerry of Course

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Joseph Leader
68 Marlborough Street
Chelsea 3-3484

CHICAGO 45, Illinois
R. H. Frish
Room 211
6349 N. Western Ave.
Ambassador 2-6005

DETROIT 35, MICH.
Harry R. Brethen Co.
16115 Meyers Road
Diamond 1-3454

EAST ROCHESTER, N. Y.
Dynatherm, Inc.
607 West Commercial Street
Phone: Ludlow 6-0082

KNOXVILLE, Tennessee
Harold J. Molloy
2100 Ailor Ave.
P. O. Box 3207
Phone: 2-5911

MILWAUKEE 13, Wis.
John Weiland, Jr.
7105 Grand Parkway
Greenfield 6-7161

ARDMORE, Pa.
Austin L. Wright Co.
P. O. Box 561
1 W. Lancaster Ave.
Midway 2-5113

Contributing vitally to the smoothly noiseless operation of Ualco Residential Awning Windows, are these molded nylon parts engineered and produced by Quinn-Berry.

In the linkage controlling the raising and lowering operation, these parts, actual size as shown above, function not only quietly and smoothly—they are tough, wear resistant "bearings" concealed within the aluminum frames. The high quality molded nylon parts add an extra value to these popular windows made by Southern Sales Sash and Supply Co., Inc. of Sheffield, Alabama.

This is but another example of the diversity of Quinn-Berry capabilities in engineering and producing components of molded thermoplastics to improve end products in world wide daily use.

Consult with us in full confidence that here, at Quinn-Berry, the "Unusual is Routine". We can serve you well.

WE FLY TO SERVE YOU FASTER!

QUINN-BERRY CORP.

2609 WEST 12TH STREET, ERIE, PA.

CUSTOM MOLDERS OF ALL TYPES OF THERMOPLASTICS

Circle 455 on Page 19

This FALK drive saves
$296 a year over this

Here's proof of economy with FALK Shaft Mounted Drives

PROBLEM—For many years, a prominent Eastern abrasives manufacturer* experienced high maintenance and down-time costs, as well as excessive noise and vibration, in the operation of 19 pebble mills driven by open spur gears. Drive gears and jack shaft pillow blocks required frequent repairs or replacement, and trunnion shafts often failed, due to radial overloading of the bull gear when broken pinion teeth bottomed between gear teeth.

SOLUTION—After numerous unsuccessful approaches to these problems, the solution was found by mounting a Size 315J FALK Shaft Mounted Drive directly on the mill drive trunnion. This eliminated objectionable gear noise and vibration...greatly reduced costly down-time and loss of production...and cut annual maintenance and replacement expenses as indicated by the following figures taken from the customer's records:

Spur Gear-and-Pinion Drive		FALK Shaft Mounted Drive	
Bull Gears	$ 56	VEE Belts	$ 30
Pinions	120	FALK Shaft Mounted Drive (based on 10-year life)	70
Pillow Blocks	90		
VEE Belts	30		
Trunnion (5-year life)	100		
Annual cost	$396	Annual cost	$100
		ANNUAL SAVINGS	$296

IF OBSOLETE DRIVES ARE COSTING YOU MONEY, a change to Falk All-Steel Shaft Mounted Drives can effect important savings in money and production. Used on almost any type of machine, these compact, rugged units are establishing new standards of economy and efficiency in many industries. Specify FALK Drives on your purchased equipment...For full details, **write for Bulletin 7100.**

*Name on request

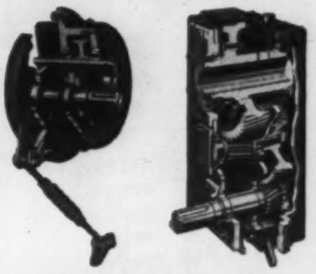
THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in Most Principal Cities

Circle 456 on Page 19

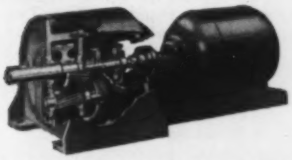
To get the right drive for your application, specify FALK®



SHAFT MOUNTED DRIVES

Horizontal or vertical units—½ to 50 hp—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 41,000 lb-in (consult factory for higher torque capacity).

• • •



ALL-MOTOR® MOTOREDUCERS

Sizes up to 75 hp—furnished with or without standard foot-mounted motor—standard output speeds 1.2 to 520 rpm (with 1750 rpm motors)—ratios as high as 54,000:1 in semi-standard designs. Integral units (gearmotor type) also available. Ask for **Bulletin 3100.**

• • •

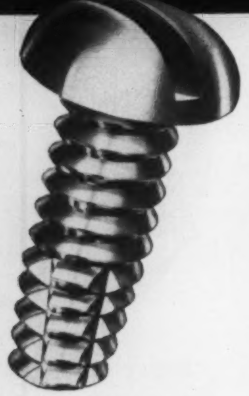
FALK Drives are available from factory and distributor stocks from coast to coast. Consult your Falk Representative or Distributor.

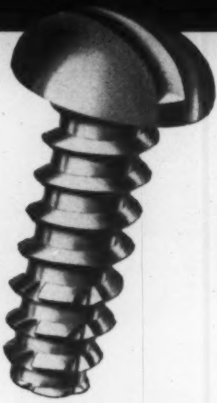
FALK

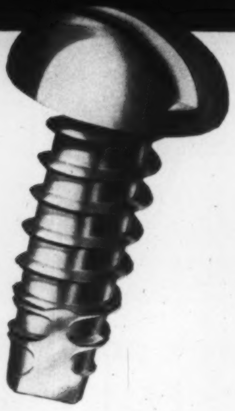
...a good name in industry

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material







1 New, Improved P-K Type F*

. . . hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.

2 "Pentap". . . the new, Improved P-K Type B-F*

(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.

3 P-K® Type L†

. . . is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because *the P-K Type L can be removed and replaced without stripping or galling.*

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.

Stop by and see us at
BOOTH 1349
Design Engineering Show,
Philadelphia. May 25-28

FOR SEMS . . . and Neoprene or Nylon washer STAPS® in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination, P-K can supply them, too!

KEEP AMERICAN INDUSTRY AT WORK . . . BUY P-K . . . MADE IN U.S.A.

*Patent Pending †U. S. Patent 2,350,346

FOR SAMPLES OF P-K THREAD-CUTTING SCREWS AND SEMS, CALL YOUR LOCAL P-K "BULK-STOCKING" DISTRIBUTOR

PARKER-KALON®
fasteners

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey • Offices and Warehouses in Chicago and Los Angeles

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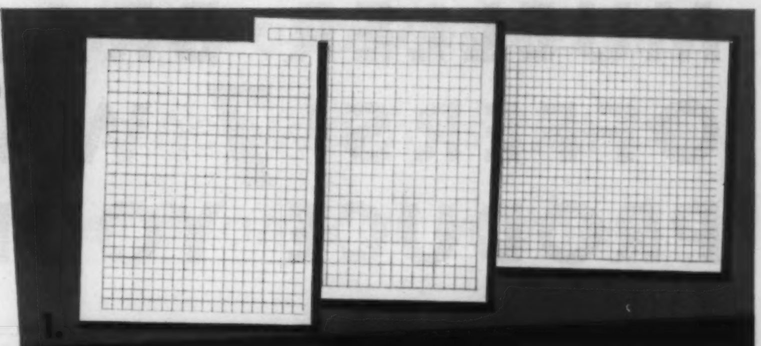

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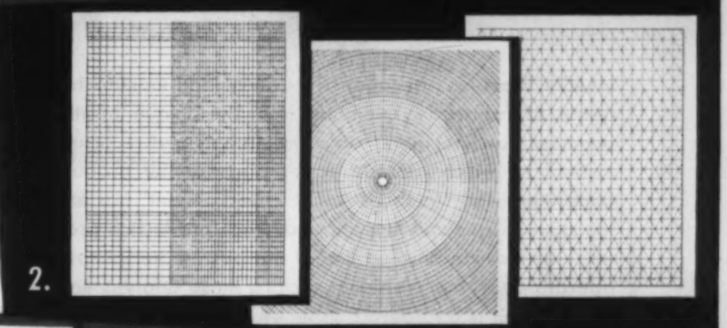

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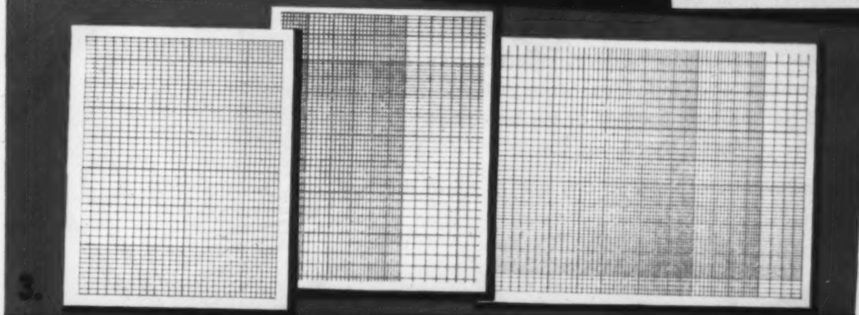

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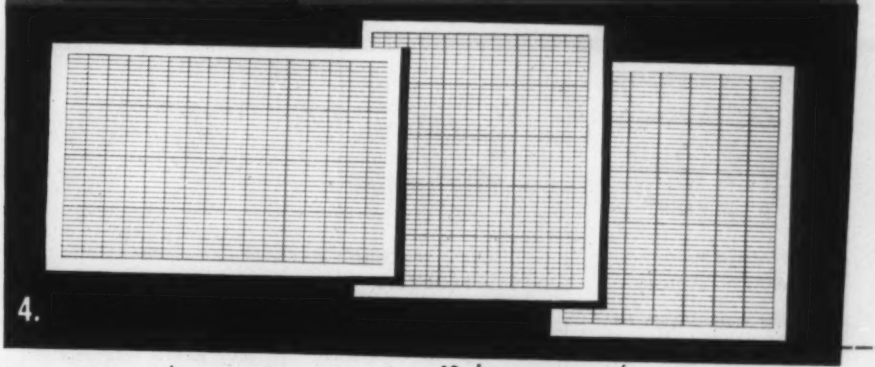

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Circle 458 on Page 19

MUELLER BRASS CO. OFFERS 7 WAYS TO PRODUCE YOUR PART

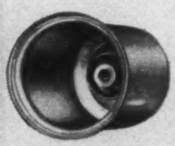
Mueller Brass Co., because of its diversified manufacturing facilities that encompass a wide range of fabricating methods, is in the unique position of being able to offer you, the purchaser, an intelligent, unbiased analysis and recommendation of the best, most economical method by which your particular part can be produced. As the result of over 40 years' experience, the "Methods Analysis Department" has at its command complete knowledge of the advantages and limitations of each production process. After receiving detailed knowledge concerning the end use of the part, material specified, conditions under which it must operate and other pertinent factors, these analysis engineers make their recommendations. Every detail is considered. In many cases, methods analysis engineers recommend a simple design change that makes practical a much more economical method of production. This technical service, offered only by Mueller Brass Co., is given to each individual inquiry and is your assurance that you will get the best product at the best price . . . made the one best way . . . by Mueller Brass Co.

Send today for free technical literature on any one or all of the seven fabricating methods.

cold-prest
IMPACT EXTRUSIONS

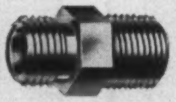
FORGINGS

Production equipment is available to produce press, hammer or cored forgings of any practical shape in sizes ranging from a few ounces to 150 lbs. in brass, bronze, aluminum and magnesium in 27 standard, as well as special, alloys.



COLD-PREST® IMPACT EXTRUSIONS

Mueller Brass Co. has complete machinery for producing Cold-Prest impact extrusions of aluminum, copper, brass, bronze and steel. Extrusions up to 28" in length are possible, depending on wall thickness and other design details. Parts can be designed having ribs, flutes, splines or bosses . . . with multiple wall diameters and with uniform or tapered wall sections.



SCREW MACHINE PRODUCTS

Mueller Brass Co. has one of the world's largest automatic screw machine departments fabricating both ferrous and non-ferrous custom parts. We can produce an infinite variety of shapes and sizes from 1/8" to 3¼" in wide range of free cutting and specialized alloys. Complete facilities for all secondary and finishing operations, as well.

POWDER METAL PARTS

Mueller Brass Co. can supply precision Sinteel® powder metal parts in wide range of sizes and metals at high production rate. Parts available from iron, brass and copper alloys. Parts may be ordered with such characteristics as self-lubrication, controlled porosity and good electrical and magnetic properties.

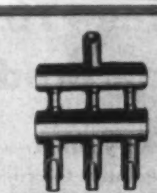
MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

MUELLER BRASS CO.

...and our methods analysis service helps you determine which is the best ...and most economical method

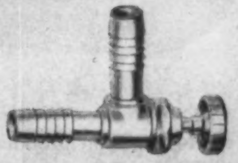
SAND CASTINGS

We specialize in the production of pressure-tight red brass castings. We utilize both metal match plate and wood patterns. Facilities include tool room and pattern shop, electric melting furnaces, high capacity core room and both bench and floor molding equipment to handle wide range of sizes.



FORMED COPPER TUBE

Mueller Brass Co. has modern facilities for forming seamless copper tube into a multitude of shapes. Forming methods used include bending, spinning, expanding or swedging, upsetting, flaring, flattening, beading and grooving, drilling and piercing, machining and joining. Formed copper tube coils are also available as single, double, spiral and serpentine shapes.



PLASTIC INJECTION MOLDING

Injection molding of plastic parts is still another process offered by the Mueller Brass Co. Parts are molded from such plastics as—nylon, polyethylenes, polyvinyl chloride, styrenes, linear acetal, chlorinated polyether, polycarbonates or polypropylene, dependent on part application.

MAN FROM MUELLER BRASS CO.

Since only Mueller Brass Co. can produce your part by all the methods, only the Man From Mueller Brass Co. can give sound advice on the one best method of production. Over 40 years of research, engineering, manufacturing and marketing experience stands behind him. When you are specifying and purchasing fabricated metal parts, call in the MAN FROM MUELLER BRASS CO.

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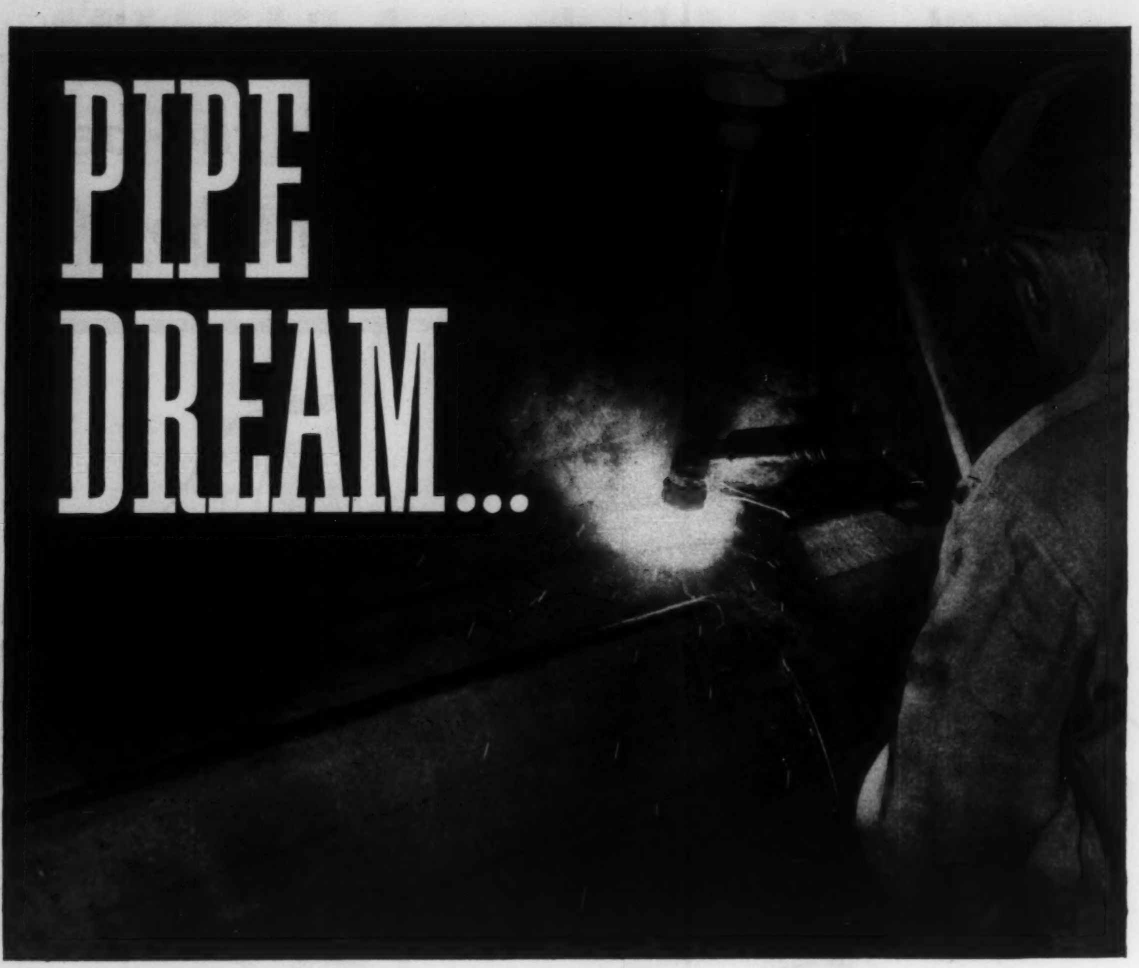
PORT HURON 20, MICHIGAN



...UNIONARC Welding saves $7000 on one production run

UNIONARC Welding—LINDE's new electric welding method for steel—increased production by 300% and saved a western pipe mill $7000 on a single run of steel pipe. Replacing covered electrode methods, UNIONARC Welding is expected to save this company $150,000 a year.

UNIONARC Welding uses a continuously-fed wire electrode, magnetically coated with flux and shielded with carbon dioxide gas. It has three times the speed and weld penetration of covered electrode welding. And UNIONARC Welding gives you "finished", X-ray quality welds and low hydrogen deposits—in all welding positions.

See for yourself—ask your nearest LINDE representative to *prove* that UNIONARC Welding slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept. Q52, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK

UNION
CARBIDE

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Circle 460 on Page 19

titeflex flexible hose made for the toughest design jobs

It is now possible to design fluid transfers that would have been impossible until recently. Here are examples of TITEFLEX advances in the flexible hose field:

ITEM: Springfield "400"* Teflon** hose in diameters to 2" . . . convoluted by an exclusive process to produce unique flexibility . . . minimum bend radius only 3⅓ times hose diameter!

ITEM: "Zero-motion" braiding . . . a TITEFLEX process that also reduces chafing of braid wire, and wear to minimum. Elongation or contraction at operating pressure less than ½ of 1%!

ITEM: Springfield "140" Teflon Hose Assemblies . . . with reusable fittings . . . factory or field installed!

ITEM: Springfield "110" Teflon Hose Assemblies . . . guaranteed against fitting blow-off at their specified temperatures and pressures!

TITEFLEX is found wherever design problems are toughest. Details and specifications are as close as your phone. Your TITEFLEX distributor is in the yellow pages, or contact TITEFLEX direct.

titeflex

*T.M. of Titeflex, Inc., Patent Pending

**Reg. T.M. of duPont

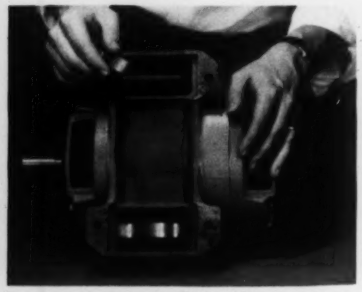
titeflex inc. springfield mass. PACIFIC DIVISION • SANTA MONICA • CALIF

Circle 461 on Page 19

Circle 462 on Page 19→

Get faster assembly–more dependable

Better Protected against dripping or splashing liquids, this G-E motor is suitable for many jobs where an ordinary dripproof motor cannot be applied.



Base-mounted Capacitors eliminate bulky capacitor "top hat," are safe from physical damage. Easy-to-remove spring clips hold capacitors in place.

Perma-Numbered Leads are always easy to identify. Non-wicking neoprene insulation prevents moisture from running up leads into vital parts.

Totally-enclosed Transfer Switch assures positive contact and long life—over 1,000,000 consecutive operations on test.

operation for your products . . .

WITH GENERAL ELECTRIC TRI 55 CLAD SINGLE-PHASE MOTORS

HERE'S WHY:

Perma-numbered leads in the G-E Tri/Clad '55' motors make connection easier because they are easy to identify. Threaded conduit entrance eliminates need for internal lock nut . . . faster installation results. And rigid cast-iron frame and endshields prevent motors from being twisted out of line during assembly operations—make machine operation more dependable.

THE SMALL SIZE AND LIGHT WEIGHT of Tri/Clad '55' standard motors facilitates installation on your products; helps reduce mounting and shipping costs *without* sacrificing full-power performance. Also, G.E.'s dripproof design allows these single-phase motors to be used for many applications which normally require splashproof type motors . . . you save money.

FOR LONGER MOTOR LIFE, G-E Tri/Clad '55' motors feature Mylar* polyester film insulation, Formex† magnet wire, water-resistant stator coating, and better physical protection. Longer motor life, of course, results in longer life and increased dependability for your products.

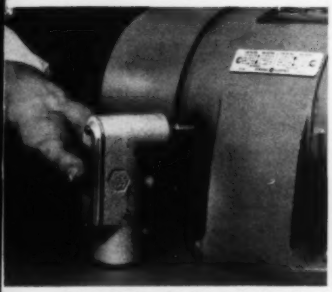
COMPARE G-E Tri/Clad '55' motors with other makes of motors. Remember: (1) General Electric offers you a complete line of single-phase motors to choose from . . . dripproof or enclosed, vertical or horizontal, C-face or D-flange, all of which meet NEMA standards. (2) You'll also be pleased with the *exceptionally* fast delivery you can get and with G.E.'s small motor service station plan . . . a real plus in cementing customer relations.

CONTACT your local G-E Apparatus Sales Office now for personal proof of how these G-E motors can help cut your costs, reduce assembly time, and give longer-life operation. And ask for your free copy of illustrated bulletin GEA-6240, or write Section 840-18, General Electric Company, Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

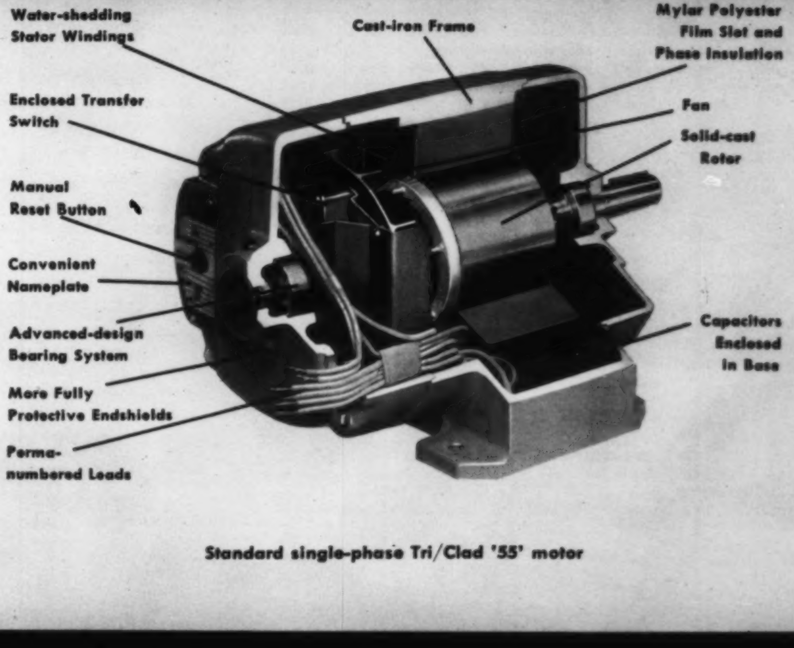
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC



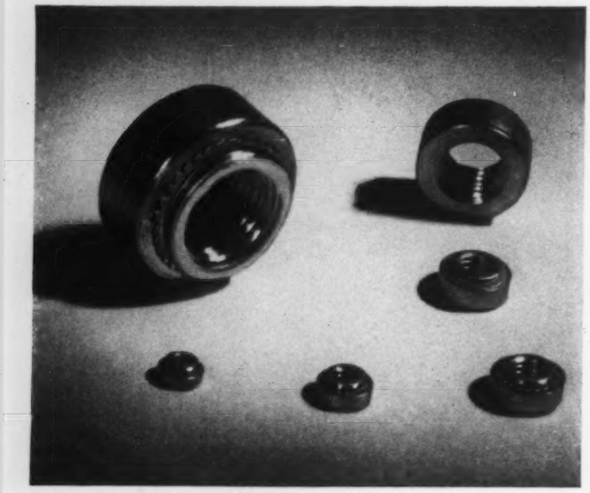
Threaded Conduit Entrance permits quick, easy installation; provides tighter, dust-proof seal for conduit.

SINGLE-PHASE TRI CLAD MOTORS OFFER THESE TIME AND MONEY SAVING FEATURES


Water-shedding Stator Windings
Cast-iron Frame
Mylar Polyester Film Slot and Phase Insulation
Enclosed Transfer Switch
Fan
Solid-cast Rotor
Manual Reset Button
Convenient Nameplate
Advanced-design Bearing System
Capacitors Enclosed in Base
More Fully Protective Endshields
Perma-numbered Leads

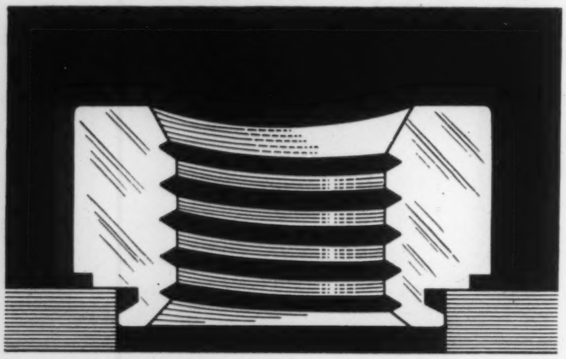
Standard single-phase Tri/Clad '55' motor

SPS RELIABILITY / *A dynamic standard of predictable performance*

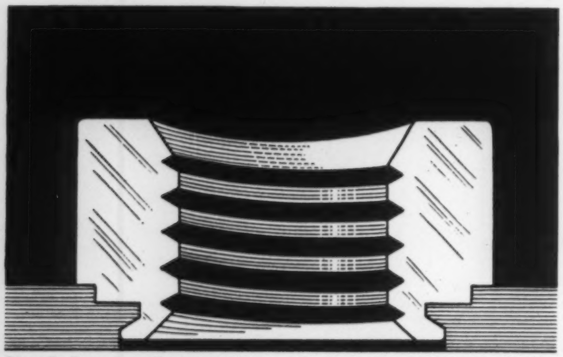


New SPS swage nuts are easily installed in steel and other sheet metals without use of clinching tools or special die fixtures. They provide handy tapped holes in thin-section assemblies, aid in blind fastening.

New SPS swage nuts simplify fastening to sheet metal



Step 1. Shank of nut slips easily into hole, serves as a positioning guide. Pressure is then applied by an ordinary hydraulic or pneumatic press fitted with flat dies or by a rivet squeezer. No clinching tools required.



Step 2. Pressure displaces sheet metal around edge of hole, forcing it into retaining groove. Knurls on swage ring increase resistance to torque-out, provide relief for metal flow. Note smooth bottom surface.

SPS swage nuts offer you a fast, economical means of putting load-bearing threads in sheet metal. They require no clinching tools, can be installed with an ordinary press fitted with flat dies. Also they do not project from the opposite side of the plate—a design advantage where minimum clearances are involved. And they do not discolor, deform or buckle the metal in which they are installed.

Push-out and torque-out values for SPS swage nuts are the highest available for fasteners of their type. This insures proper torquing of screws and increases reliability under working loads and vibration.

New SPS swage nuts can be used in metals with a hardness up to approximately Rockwell C25. This includes steel, as well as the usual alloys of copper, Monel and aluminum. Swage nuts come in sizes #2 through ½ in. (2B threads), with shank lengths for plate thicknesses from .020 to .250 in.

For new Bulletin 2447 or samples, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium. Aircraft/Missiles Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

SPS Jenkintown • Pennsylvania

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.

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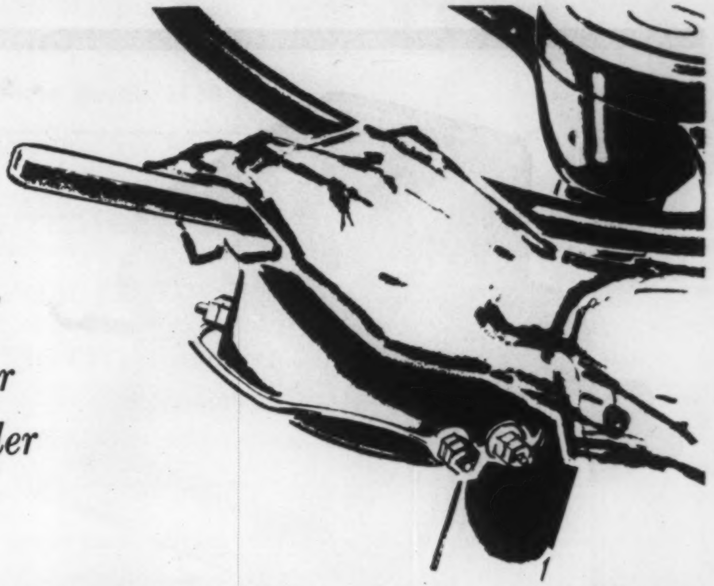
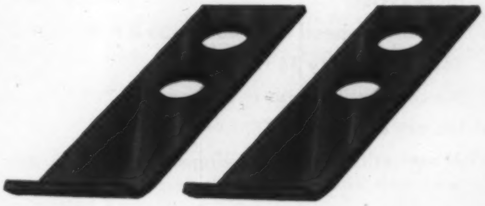
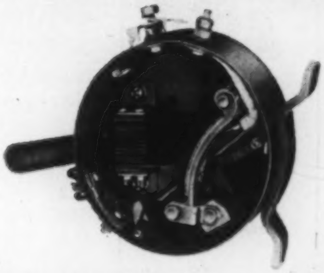


Instantly,
Smoothly,
new "Contact Bronze"
applies graduated power
to heavy-duty trailer
brakes

CONTACT!



COSTS 25% LESS
These contact leaves are stamped and formed from Bridgeport "Contact Bronze" Alloy 92 at a savings of 25%. Its performance-proved spring properties provide part reliability through thousands of cycles.



FORMS EASILY
Warner Electric Brake system for heavy-duty trailer combination is actuated by this controller. This view shows the series of easily formed "Contact Bronze" leaves that transmit power in smoothly graduated steps.

This ingenious electric brake system devised by Warner Electric Brake & Clutch Company gives the driver instantaneous synchronization of all brakes. Through a graduated series of Bridgeport "Contact Bronze" leaves, it lets the driver adjust torque smoothly to suit load and road conditions.

"Contact Bronze" Alloy 92 saves up to 25% on material cost. Its quality and dependability are maintained by the addition of a minute quantity of phosphorus for superior spring properties. It easily withstands difficult forming operations without losing its spring properties.

If you form or stamp contact parts for electrical or electronic equipment, you will want details on "Contact Bronze," as well as Bridgeport's other alloys for the electrical industries. Call your nearby Bridgeport sales office for immediate service or, for samples and a copy of the "Contact Bronze" data sheet, write to Dept. 4303.

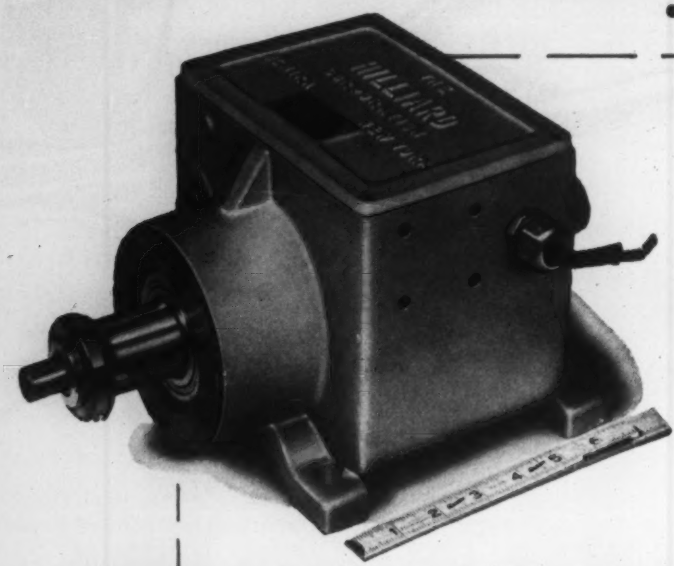
Brass Bridgeport Co.

BRIDGEPORT BRASS COMPANY

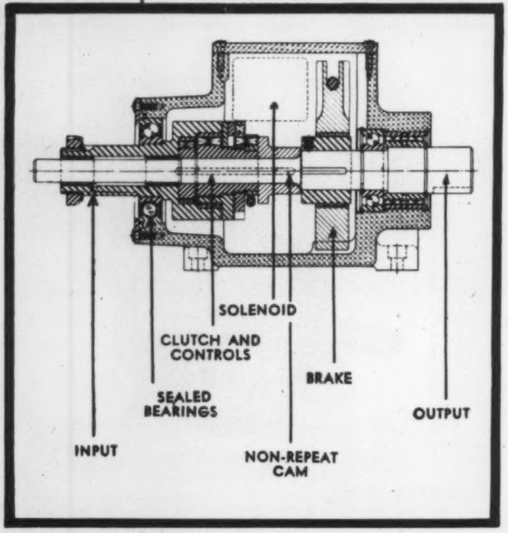
Bridgeport 2, Conn. • Sales Offices in Principal Cities

Specialists in Metals from Aluminum to Zirconium

• See the new HILLIARD I.D.U.



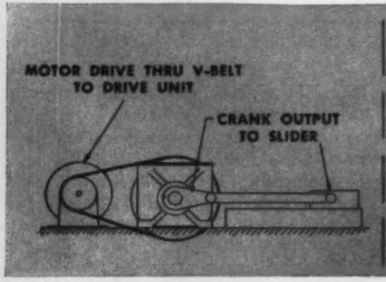
NEW "I.D.U."

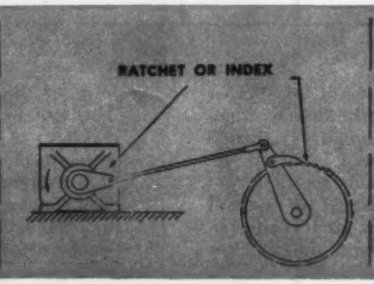

SOLENOID
CLUTCH AND CONTROLS
BRAKE
SEALED BEARINGS
OUTPUT
INPUT
NON-REPEAT CAM

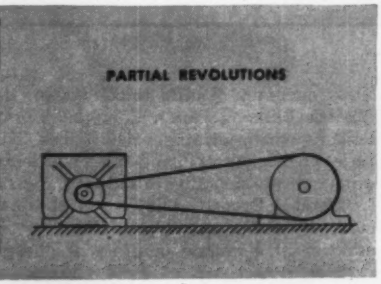
"Intermittent Drive Unit" contains all the parts in one package . . .

- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

BASIC UNIT PRICE $289
Optional Accessories Extra


MOTOR DRIVE THRU V-BELT TO DRIVE UNIT
CRANK OUTPUT TO SLIDER


RATCHET OR INDEX


PARTIAL REVOLUTIONS

The HILLIARD Corporation manufacturers of industrial clutches for over 50 years
SINGLE REVOLUTION • OVER-RUNNING • SLIP • TWIFLEX • I.D.U.

at the Design Engineering Show Booth 1138 •

HILLIARD'S Complete Package Unit that converts rotary power to precise intermittent motion . . .

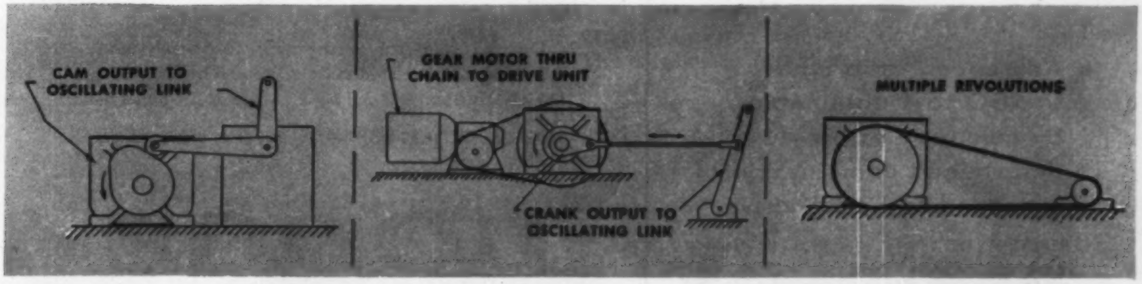
Can be installed on existing equipment, designed into new machinery and re-used after production line changes

Now you can get a single package unit that gives you precise control of intermittent motions . . . clip and bend . . . shear or slash . . . oscillate or repeat . . . raise or lower . . . index and position . . . from a constantly rotating source of power. The HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a special "custom" machine with assorted mechanisms to apply and control it.

With an "I.D.U." you can mechanize hand or foot operated equipment, modernize or automate existing power operated machines and use it as a "building block" in designing or constructing new machinery or production drives.

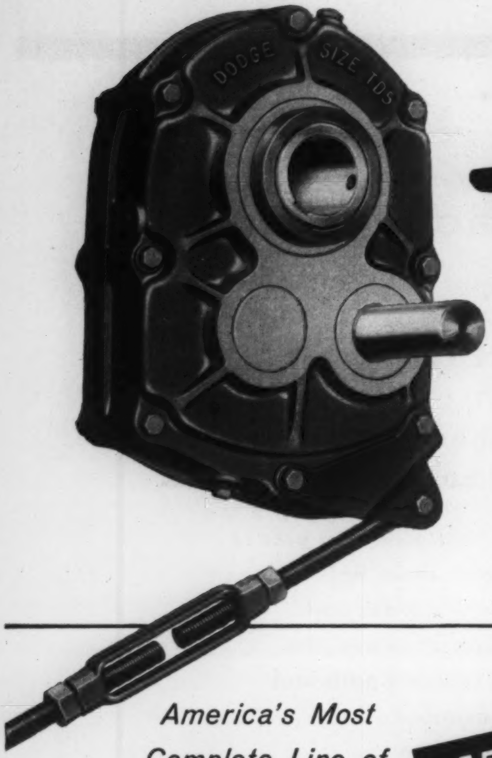
The "I.D.U." features highly flexible control, manual, mechanical or electrical, permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "wash-down" conditions.

- *Investigate HILLIARD'S "I.D.U." for your equipment. Write on your letterhead stating your intermittent motion problems and we will provide complete information.*


CAM OUTPUT TO OSCILLATING LINK
GEAR MOTOR THRU CHAIN TO DRIVE UNIT
CRANK OUTPUT TO OSCILLATING LINK
MULTIPLE REVOLUTIONS

THE HILLIARD CORPORATION 103 W. FOURTH ST., ELMIRA, N. Y.

IN CANADA—UPTON-BRADEEN-JAMES, LTD.—890 YONGE ST., TORONTO—8760 VERVILLE ST., MONTREAL



See the big one at the Design Engineering Show Booth 1105

Torque-Arm

THE DODGE DEVELOPMENT THAT CHANGED THE NATION'S HABITS OF SPEED REDUCTION

America's Most Complete Line of Shaft Mounted Speed Reducers

55 MODELS

- 1 to 200 hp. at 100 rpm!
- Output speeds from 10 to 378 rpm!
- Single Reduction
- Double Reduction
- 5 to 1 Ratio
- 15 to 1 Ratio
- 25 to 1 Ratio
- Any speed ratio up to 150 to 1 obtainable by selection of predetermined combination of reducer and V-belt drive.

In fewer than ten years, the range of Torque-Arm Shaft Mounted Speed Reducers has increased from 6 to 55 models, to meet the ever increasing demand for this improved method of speed reduction.

By eliminating foundation, sliding base and flexible coupling this modern speed reducer has saved untold installation time and untold dollars of cost.

The rugged semisteel housing developed by Dodge has never been improved upon. It is corrosion resistant—and it has the strength to hold bearing seats in line for the life of the unit.

Dodge design provides wide spacing for the bearings. Loads are carried easily, contributing to Torque-Arm's long life and very high efficiency. The gears are finest quality—helical, heat treated steel.

Torque-Arm mounts vertically or horizontally in any position around the driven shaft. It locks to the shaft on *both* sides of the housing. The holes in the output hub provide simple removal with puller. Overload release and built-in backstop are optional.

Dodge Torque-Arm is America's most widely used shaft mounted speed reducer. It is stocked by your local Dodge Distributor. Ask him. Or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 3300 Union, Mishawaka, Ind.

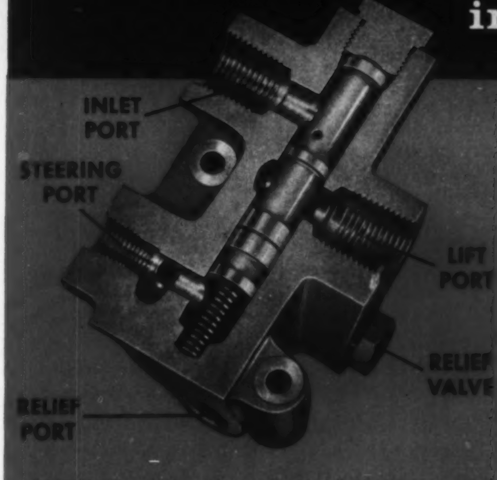
CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE

of Mishawaka, Ind.

DYNAMIC DIFFERENCE

in hydraulic performance



BULLETIN HY1 contains performance and installation data on the complete line of Webster positive displacement gear type pumps, fluid motors and valves. Write for your copy.

Call the man from Webster

. . . he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design!

photo courtesy of THE FRANK G. HOUGH CO., Libertyville, Illinois

Webster

HIGH CAPACITY FLOW DIVIDERS

Material moving magic! 20 cubic feet at a bite, this highly maneuverable front-end loader cuts big piles down to size — without missing a beat. Hydraulics play an important roll here — in power steering, in powering the bucket. But there's only *one* hydraulic pump. A Webster flow divider supplies *both* hydraulic circuits — and permits each to be operated *simultaneously* at different pressures from a *single pump!*

There are more advantages . . . Webster flow dividers operate at pressures up to 2000 psi, capacities to 60 gpm. They're small, compact to fit easily in tight quarters on mobile equipment. Adapt easily and economically to your product and the job.

When *you* plan hydraulics, plan on Webster . . . *for the dynamic difference that pays!*

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE · WIS

our 50th year

[illegible] H-115

added precision for your products

Beaver Ball Screws, Splines, Ways

Wing flaps of Boeing's monster 707 jet are actuated by Beaver ball screws. This is but one of more than 20 famous commercial and military aircraft that rely on Beaver, exclusively, for control of vital operating parts where precision, space, weight and power requirements are paramount design considerations.

This tape controlled skin mill, manufactured by Hypro Division of Giddings and Lewis Machine Tool Co., employs four Beaver Precision ball screws up to 35 feet long. They control vertical and horizontal positioning of cutting heads and swiveling of the work chuck.

Gain optimum positioning control with system stiffness—Reduce 'stixion' to a minimum

In a Beaver actuating device which employs rolling balls to eliminate friction encountered with the acme screw, engineers find many accompanying advantages. By preloading, a degree of system stiffness is accomplished to control motion with greater precision than ever before possible, while power and space requirements are reduced along with weight. Static friction closely approaches kinetic friction. Back-lash and surge are eliminated. Beaver ball screws rate better than 90% efficient.

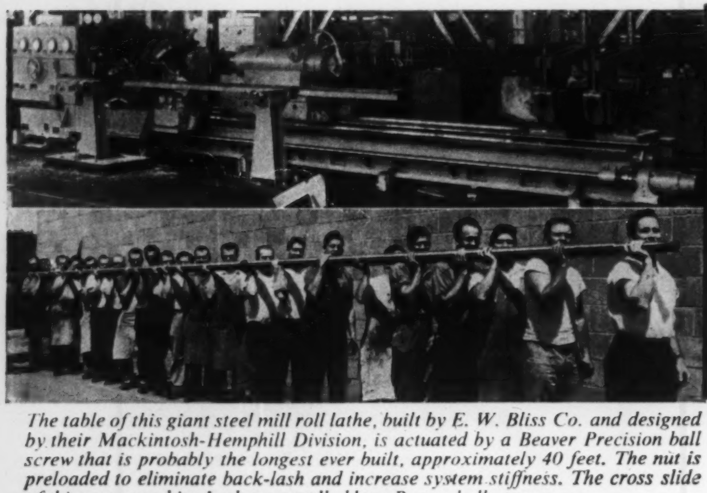
Beaver occupies a dominant position in the area of ball screw application engineering. The company's facilities are planned not only for furnishing production requirements, but for assisting manufacturers through experimental and prototype stages. Size and quantity are no factor.

CONTRIBUTES TO NUMERICAL CONTROL EFFICIENCY

Beaver has made major contributions to the effectiveness of tape and card control of machine tools. In a minimum of space, with a minimum of power, Beaver ball screws provide precise control and repeatability in table feeds and other horizontal and vertical axes. As a result they are specified exclusively by an impressive list of leading machine tool manufacturers.

Our engineers are available to discuss your design problems with you.

VISIT OUR BOOTH
1608
DESIGN
ENGINEERING SHOW
PHILADELPHIA
MAY 18 to 25



The table of this giant steel mill roll lathe, built by E. W. Bliss Co. and designed by their Mackintosh-Hemphill Division, is actuated by a Beaver Precision ball screw that is probably the longest ever built, approximately 40 feet. The nut is preloaded to eliminate back-lash and increase system stiffness. The cross slide of this same machine is also controlled by a Beaver ball screw.

Beaver
Precision
Products
INC.
CLAWSON, MICH.

Circle 467 on Page 19

MORE ABOUT THE GARLOCK 2,000

(above) Fresh driver takes over underway during 50,000 mile test conducted by Kiekhaefer Corporation, makers of Mercury Outboard Motors. (right) KLOZURE Model 71A7 used on the Mercury has exclusive non-abrasive, free running sealing element resistant to oil, water, grease, heat and cold.

50,000 MILE OUTBOARD TEST

PROVES ENDURANCE OF GARLOCK KLOZURE* *OIL SEALS, TOO!*

In a fantastic non-stop endurance run equal to 20 years of average family outboarding, Garlock KLOZURE Oil Seals maintained positive sealing against grease and water without sign of physical wear or deterioration. Applied on the steering swivel shaft of two Mercury Mark 75E outboards, KLOZURES worked 'round the clock for 68 straight days keeping grease in the bearings. Hard knocks from rough water, floating obstacles, and foreign matter picked up at surface speeds averaging 30 miles per hour, could not injure the KLOZURES.

What better proof is there of long life and dependability! Garlock KLOZURE Oil Seals are compact, easy to install, and are available from one of the largest stocks of standard sizes for shafts from 1/8" to 44". Whether it's in boating or industry, specify Garlock for the most effective seal on the market.

KLOZURES are another of the Garlock 2,000 . . . two thousand different types of packings, gaskets, and seals. The only complete line. It's one reason you get unbiased recommendations from your Garlock representative. Call him or write for KLOZURE Catalog 20.

*Registered Trade Mark

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

Circle 468 on Page 19

ONLY RAMCO MAKES BOTH TYPES OF MODERN RETAINING RINGS

UNIQUE

SpirOlox

A time-tested Ramco design; full-circle 360 degree retaining ring opens up unlimited possibilities for improved design and economies in thousands of new or present products.

- √ Uniform wall allows installation with minimum clearance.
- √ Two turn, full-circle design eliminates gaps.
- √ No special tools needed for installation or removal.
- √ No tooling needed for prototypes.
- √ Develops "friction lock" under load.
- √ Single or multi-turn designs.
- √ Always uniform in quality.
- √ Special designs for high speeds or tolerance stack-up problems.

IMPROVED

CircOlox

The answer to easy, lightweight, low cost assemblies and reduced manufacturing costs. Made in a variety of types and sizes for the smaller shaft or housing diameters.

- √ "Deep-groove" design permits maximum thrust with minimum weight.
- √ Easily installed or removed.
- √ Available in a variety of materials.
- √ Wide choice of finishes.
- √ Always uniform in quality.
- √ Meets Government and Industry Standards.

Retaining Rings by Thompson Products

another product of **Thompson Ramo Wooldridge Inc.**

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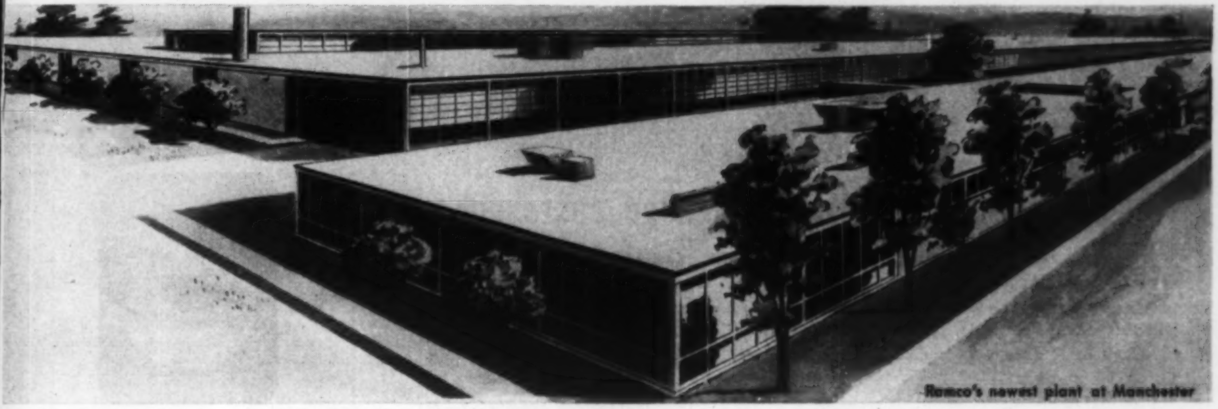
ASSEMBLED COST? APPEARANCE? PERFORMANCE?

WHAT IS YOUR MAJOR FASTENER PROBLEM?

If it is assembled cost, Ramco retaining rings can give you the one best answer



Ramco's newest plant at Manchester

To cut assembled cost . . . thousands of manufacturers have adopted either Ramco Spirolox or Circolox designs. Whichever of these modern retaining rings provide the one best answer to the problem . . . Ramco engineers can design and the world's most modern retaining ring plant can deliver!

Whatever it takes . . . rings designed from standard or special materials . . . designs for quick, easy assembly or with special tolerances . . . you can depend on Ramco to deliver The One Best Answer. Only Ramco can supply retaining rings in a complete range of sizes from 1/16 inch to 40 inches in diameter.

In addition to cutting assembled costs . . . you can depend on Ramco Spirolox and Circolox to solve problems of appearance and performance. As a Ramco Spirolox-Circolox customer you have the engineering know-how of one of the nation's great organizations at your service to provide you with the ONE BEST ANSWER TO YOUR RETAINING RING PROBLEMS! Why not mail the coupon today . . . let us help you with any of your problems.

RAMCO DIVISION

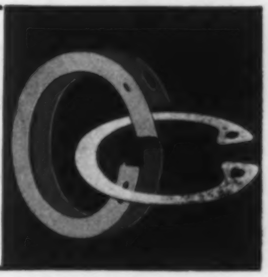
automotive group

TRW

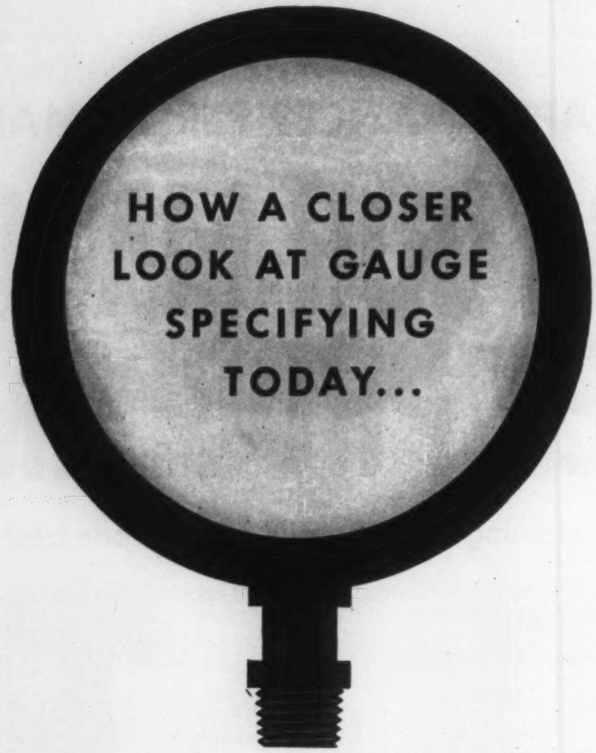
Thompson Products Ramco Division
Box 513, Dept. B, St. Louis 66, Mo.

Send latest Engineering and Price Catalogs of Spirolox and Circolox Retaining Rings.

Name..Title....................
Company..
Address...
City...................................Zone.......State..................
Samples Wanted: Spirolox ☐ Circolox ☐ Size.......



Circle 469 on Page 19



can keep you up on keeping gauge costs down

If you have a new product coming up, or design changes for a present product, and need *any* type of pressure gauge . . . you will get your gauge faster and save more by checking United States Gauge first. For these reasons:

First, USG has 50,000 standard gauges to draw on. Second, USG knows thousands of modifications possible with standard gauges to meet special design requirements more economically. Third, the men at USG know your competitive need to design better performance into equipment and deliver faster, while reducing costs.

Finally, at USG you will get exactly the gauge accuracy and performance you want for your purpose and price . . . up to and including the finest high-precision test gauges made.

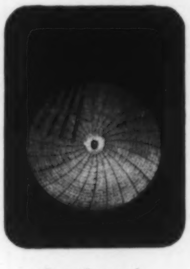
Today, USG gauges are specified by 6 out of 10 original equipment manufacturers. For a closer look at dependable performance and lower costs in your next gauge need, call your USG distributor, listed in the Yellow Pages. Or write direct to United States Gauge.

®USG **UNITED STATES GAUGE**

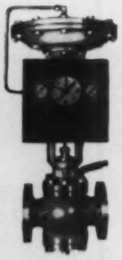
Division of American Machine and Metals, Inc., Sellersville, Pennsylvania

Test Gauges

Pneumatic Receivers


Recorders and Recorder-Controllers

Drawn Case Gauges (Brass or Steel)


Indicating "Pilot" Controllers and Transmitters

Solfrunt® (Supergauge) with blow-out back

Supergauge® (A.S.A. Grade AA) Line

A-Line (A.S.A. Grade A) Gauges

Drawn Case Thermometers, too

Circle 470 on Page 19

HYDRECO®
HYDRECO

Note these Advantages!

Externally adjustable pilot operated system relief valve.

●

Exceptional throttling — superior operator control.

●

Balanced plungers unaffected by high back pressures.

●

Machine operation can often produce high static pressures in blocked cylinder circuits. Built-in pilot operated relief valves may be provided in V-33 Valves as required for individual circuits.

●

All ports are machined for S.A.E. straight thread connections and TUBE-O fittings.

●

Swing cylinder circuits can be fully protected. Any plunger can be provided with built-in pilot operated cushion relief valves.

NEW HYDRECO VALVE

V-33 Series Parallel Circuit for Mobile Equipment

Here's a complete Fluid Power Circuit in one housing. All extra required circuit features are built into a single, space-saving package . . . recommended for 20 gpm at 2000 psi.

Pressure drop through the open center or the operating plungers is low. HYDRECO V-33 Valves can handle more than their rated capacity with little loss in efficiency. Their small size makes them easy to install . . . no special fittings needed, either.

Check the *design advantages* of HYDRECO V-33 Valves for your mobile equipment.

Write

Get the facts on this new HYDRECO V-33 Valve

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
9006-5 EAST MICHIGAN • KALAMAZOO • MICH.

Please send me Bulletin No. 10,175.1 fully describing the New HYDRECO V-33 Parallel Circuit Valve for Back Hoes.

Name________________________________

Company_____________________________

Address______________________________

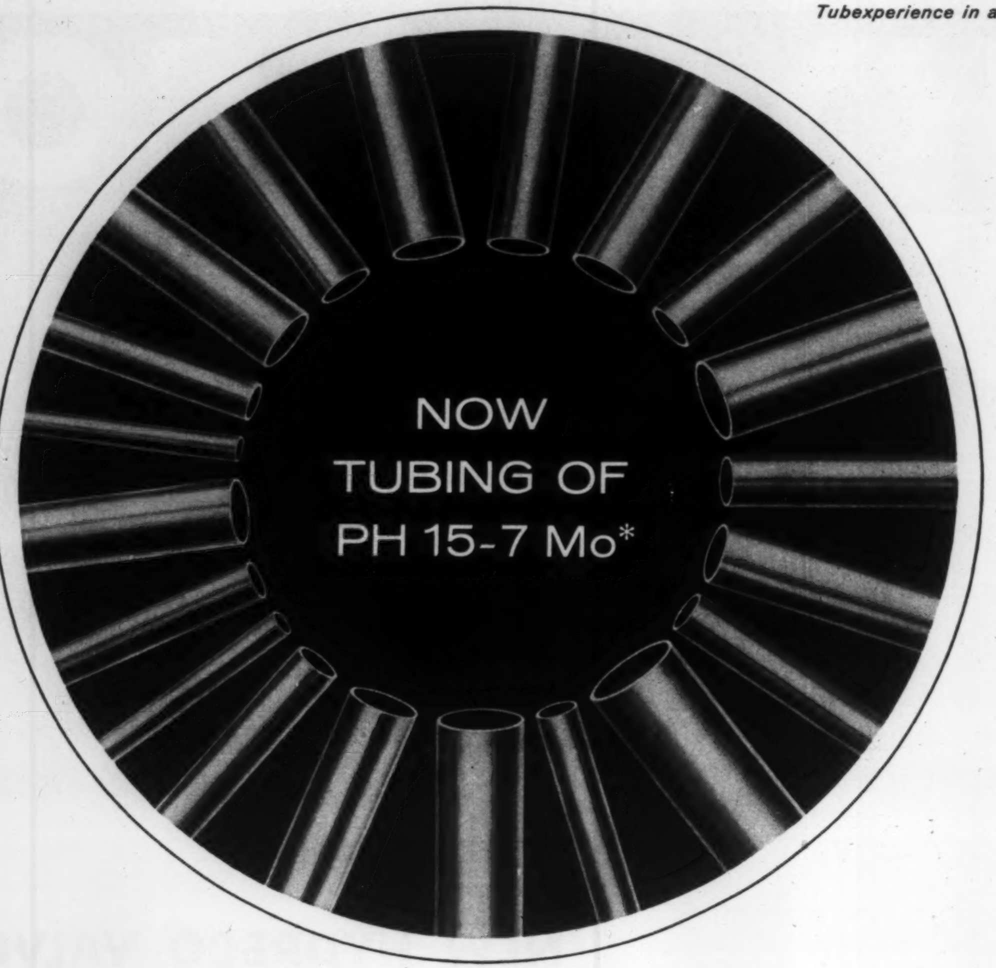
City________________Zone_____State______

Member NFPA

NFPA NATIONAL FLUID POWER ASSOCIATION

Circle 471 on Page 19

Tubexperience in action



New High-Strength Material Extends Superior Line of Stainless Steel Tubing Analyses

PH 15-7 Mo, a new precipitation-hardening stainless steel analysis, possesses excellent mechanical properties at room temperature, outstanding ones at elevated temperatures. In addition, it is readily fabricated in the annealed condition, exhibits good corrosion resistance characteristics, can be hardened by heat treatment with minimum distortion.

Tubing of this new analysis is recommended for aircraft structural parts, studs and bushings, Bourdon springs and torque tubes in instrumentation, tubular springs, and hydraulic lines where severe bending and forming are required. It is available in WELDRAWN® form in size range from .012 through 1.125 in. OD.

In addition to PH 15-7 Mo, Superior offers the widest variety of analyses in the small-diameter tubing industry—over 120. This range permits you to specify the right one for your particular application. For complete information about PH 15-7 Mo and other analyses available for your needs, write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

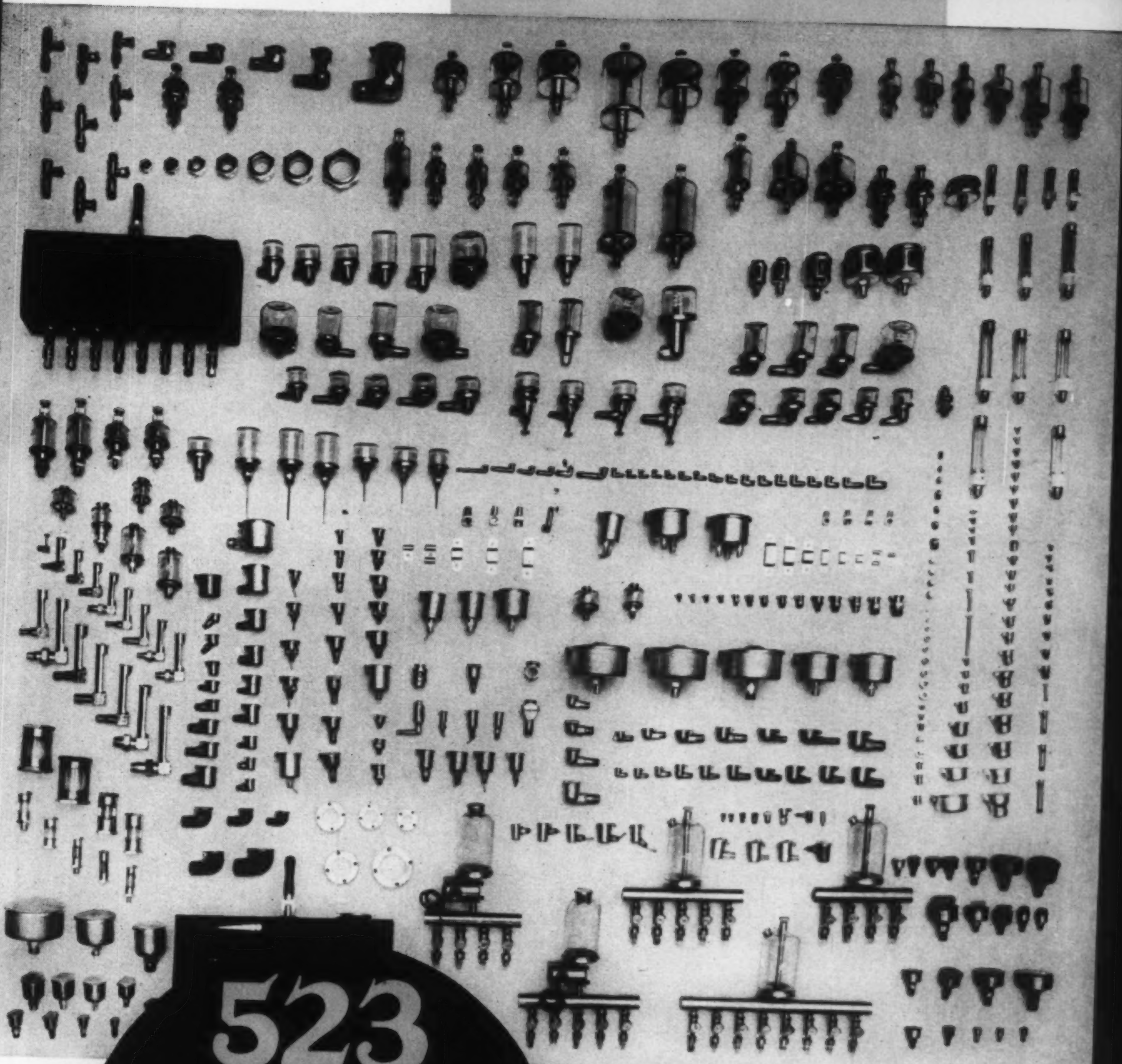
*Reg. U.S. Pat. Off., Armco Steel Corp.

Superior Tube

The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to 5/8 in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST



523
GITS OILERS AND GAUGES READY TO SHIP

Largest selection available anywhere. You save time and money, because the one you want is always right in stock. Send for complete Catalog.

Specialists in Lubricating Devices and Shaft Seals for Almost Half-A-Century

GITS
GITS BROS. MFG. CO.

GITS BROS. MFG. CO.
1868C S. Kilbourn Ave., Chicago 23, Ill.

Circle 473 on Page 19

What a build!

... solid state components in New Fenwal Temperature Controller combine precision with extra reliability

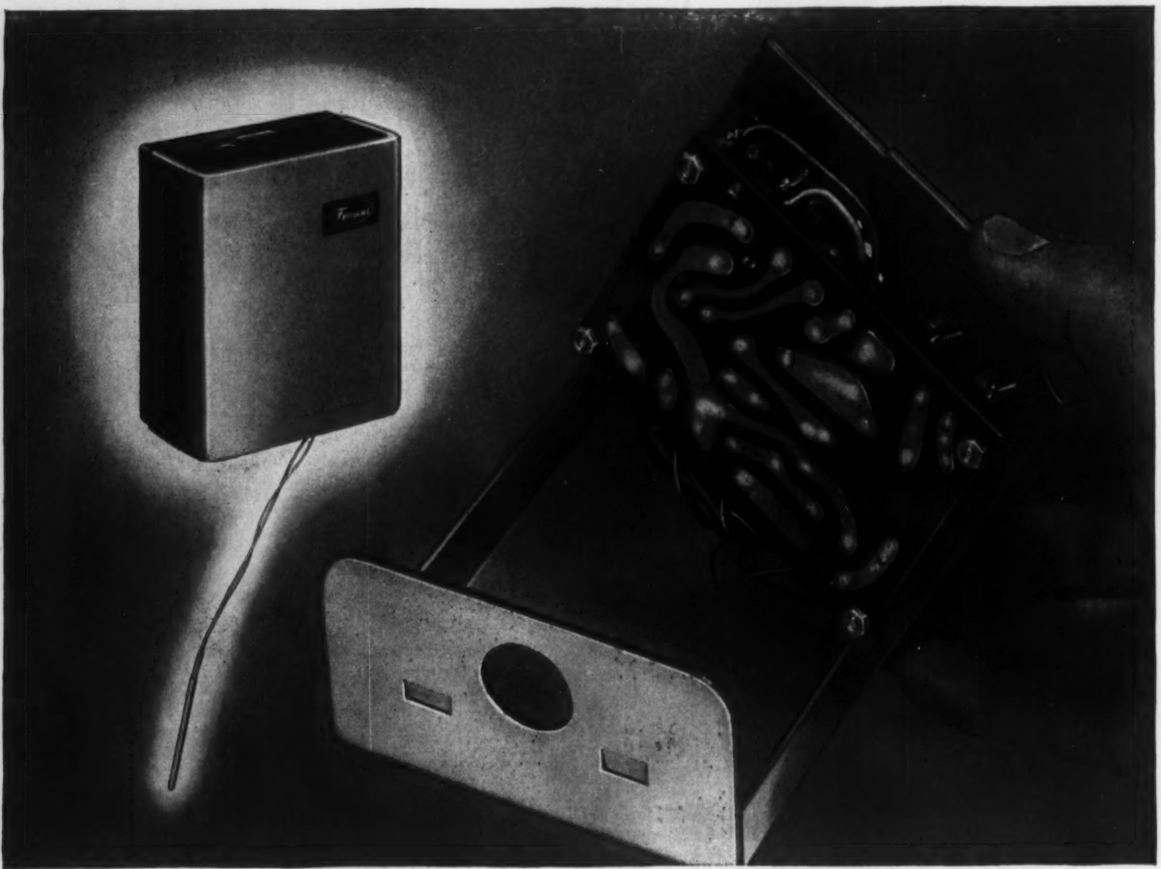
Here's a new, low-cost temperature controller that's really built "solid": thermistor sensing element, printed circuit, transistors. *No wonder the Fenwal 535 Temperature Controller provides high precision, trouble-free operation and long life!*

The Model 535's solid state components pay off in simplicity and dependability. The thermistor sensor mounts up to hundreds of feet from the controller using uncompensated electric wiring; has virtually limitless life; feeds into a rugged transistor amplifier. *No moving parts . . . nothing to wear out!*

The Model 535 is the latest advance in the low-cost line of Fenwal Temperature Controllers specifically developed to fully exploit the advantages . . . rapid response, compact size, reliability . . . of solid state components. *And Fenwal, alone, has integrated production of both controllers and thermistors.*

Use the Fenwal Model 535 Controller for fast response and close control of temperatures from −25°F to +600°F in plastics, packaging, or other critical applications. Get full details from a Fenwal Sales Engineer or write for catalog. Fenwal Incorporated, 195 Pleasant Street, Ashland, Mass.

Single point Model 535 Fenwal Temperature Controller has 2°F setting accuracy and sensitive operating differentials from 0.4°F to 1.2°F. Current capacity: 5 amps. 115 volts AC — 10 amp. model later in 1959.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

Circle 474 on Page 19

CONTROL FLUID FLOW
with Micrometer Accuracy
HANNA
Flo-Set
VALVES
Flow
40
50
60
70
HANNA
Flo-Set
FREE FLOW
LOCK
HANNA ENG.

For AIR, OIL and WATER operation to 250 p. s. i.
SIZES ¼" · ⅜" · ½" · ¾"
TEMPERATURES to 250°F

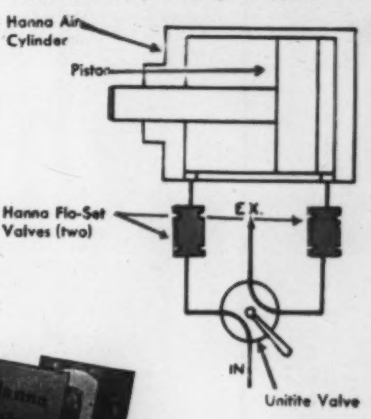
■ Hanna Flo-Set Valves are used to control cylinder piston speeds and operating speeds of many types of fluid actuated mechanisms. They are able to handle air, oil, water and many gases. When used with cylinders, these valves permit independent adjustments of forward and return piston speeds. The diagram at the right shows a typical circuit. Flo-Set Valves make the operation of air cylinders smoother and make cushioned cylinders more effective by building up essential back pressure.

Fluids pass unobstructed in the direction of the arrow on Hanna Flo-Set Valves. In the opposite direction, flow can be controlled from zero to full pipe capacity. One valve can be set to an infinite number of controlled flow positions. Once set, the position can be held by means of a locking collar. Established flow positions can be reset by using the micrometer graduations which accurately measure flow as a percent of full pipe capacity.

One revolution of the aluminum valve body will change the flow rate from zero to full capacity. No tools are necessary! In addition to the standard ¼", ⅜", ½" and ¾" sizes, there is a ¼" Jr. model, without micrometer graduations or locking collar, for light piping and tubing.

Typical Cylinder Circuit Using Hanna Flo-Set Speed Control Valves

Hanna engineers will gladly recommend circuits to help you with your applications.


Hanna Air Cylinder
Piston
Hanna Flo-Set Valves (two)
EX.
IN
Unitite Valve

Hanna Valves

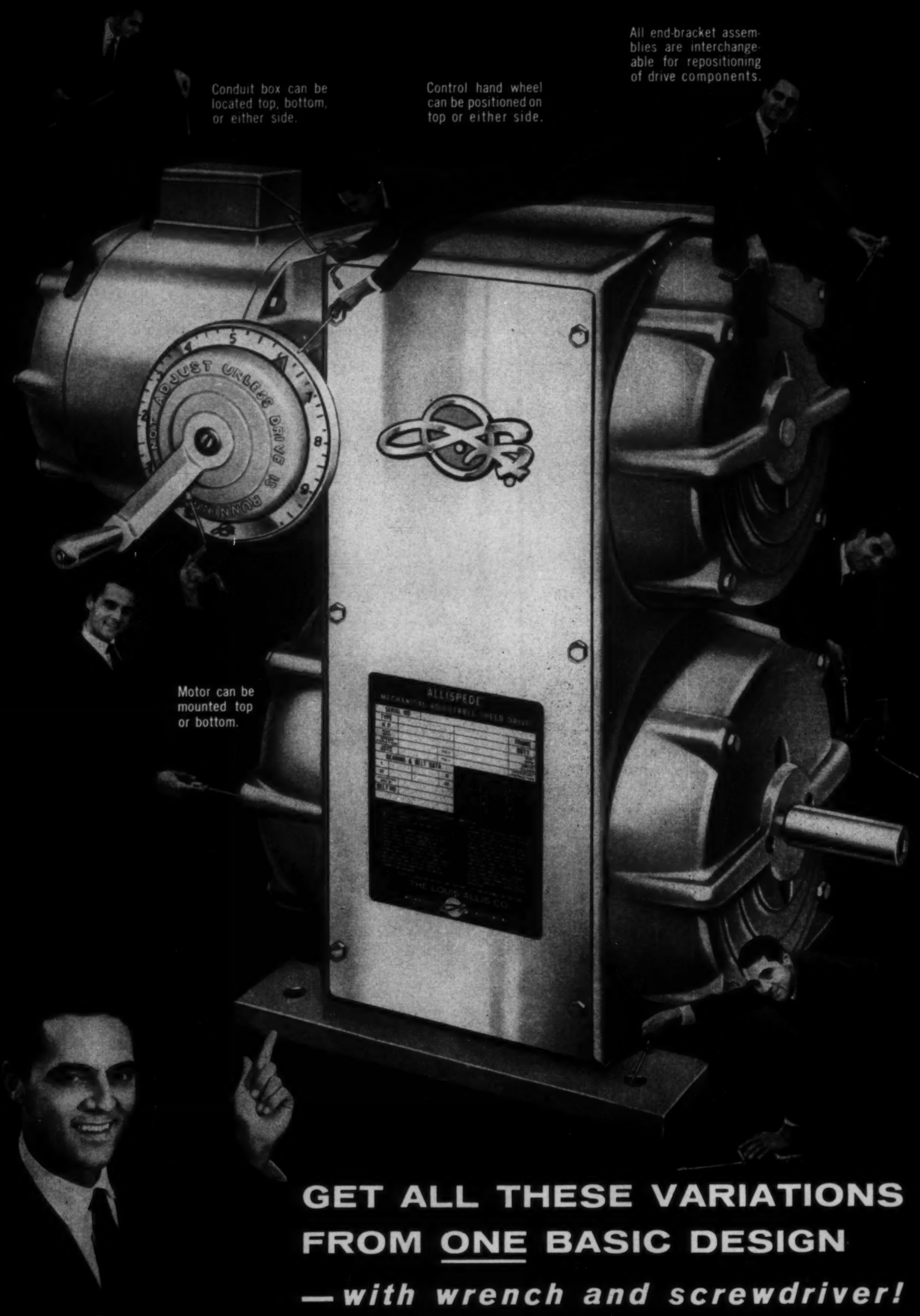
Consult your classified telephone directory or Thomas' Register for your nearest Hanna representative. Write for Hanna Valve Catalog 254 and Flo-Set Valve Bulletin 253A.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

1751 Elston Avenue • Chicago 22, Illinois

Circle 475 on Page 19


DO NOT ADJUST UNLESS DRIVE IS RUNNING
ALLISPEDE
MECHANICAL ADJUSTABLE SPEED DRIVE
THE LOUIS ALLIS CO.

Conduit box can be located top, bottom, or either side.

Control hand wheel can be positioned on top or either side.

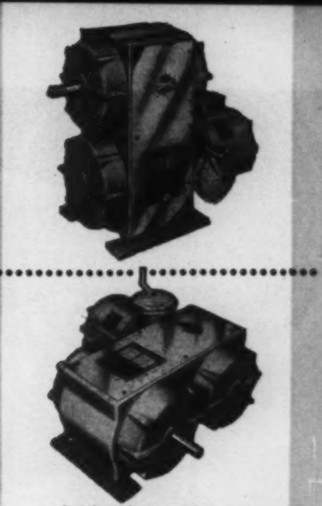
All end-bracket assemblies are interchangeable for repositioning of drive components.

Motor can be mounted top or bottom.

GET ALL THESE VARIATIONS
FROM ONE BASIC DESIGN
—with wrench and screwdriver!

Output shaft can be high or low, right or left.

Detachable feet can be bolted to bottom, side, or top for floor, wall, or ceiling mounting.



Another NEW product from Louis Allis

Just two of many variations that can be made from a standard ALLISPEDE DRIVE.

The ALLISPEDE* DRIVE gives you complete design versatility!

"Building-block" principle, using one basic unit, permits this drive to fit into any design requirement regardless of space or shape limitations!

The *all-new* ALLISPEDE DRIVE is a simple answer to the problem of providing low-cost adjustable speed in a variety of designs. The basic unit goes together like blocks — you pick the assembly you want — locating feet, end brackets, control hand wheel, conduit box, and output shaft to suit the requirements of the driven machine.

The same unit can be used for horizontal or upright floor, wall, or ceiling mounting — there are no "fixed" components to limit installation. And all of these adjustments are easily made in minutes with just a wrench and screwdriver, right on your assembly floor! As a result, a lower inventory of drives still covers your production requirements.

Superior design improves drive efficiency and extends service life. The four bearings equally distribute belt load, increasing bearing and belt life. Movable discs slide smoothly on internally-lubricated splined shafts — won't stick in place or wear.

Rugged cast-iron housing with plated steel covers shields drive against dirt and corrosion . . . integral rotor fan cools the motor and force-ventilates the drive housing to extend bearing life. Oversize cartridge bearings are pressed on shaft and lubricated at the factory. Corrosion-resistant stainless-steel nameplates diagram proper motor connection, specify bearing sizes, and carry complete instructions for operation and lubrication.

The ALLISPEDE DRIVE can be supplied with in-line or right-angle integral gears, brake, and tachometer. Sizes from 1 to 20 HP, with speed variations up to 8:1. Electrical and mechanical modifications for any application.

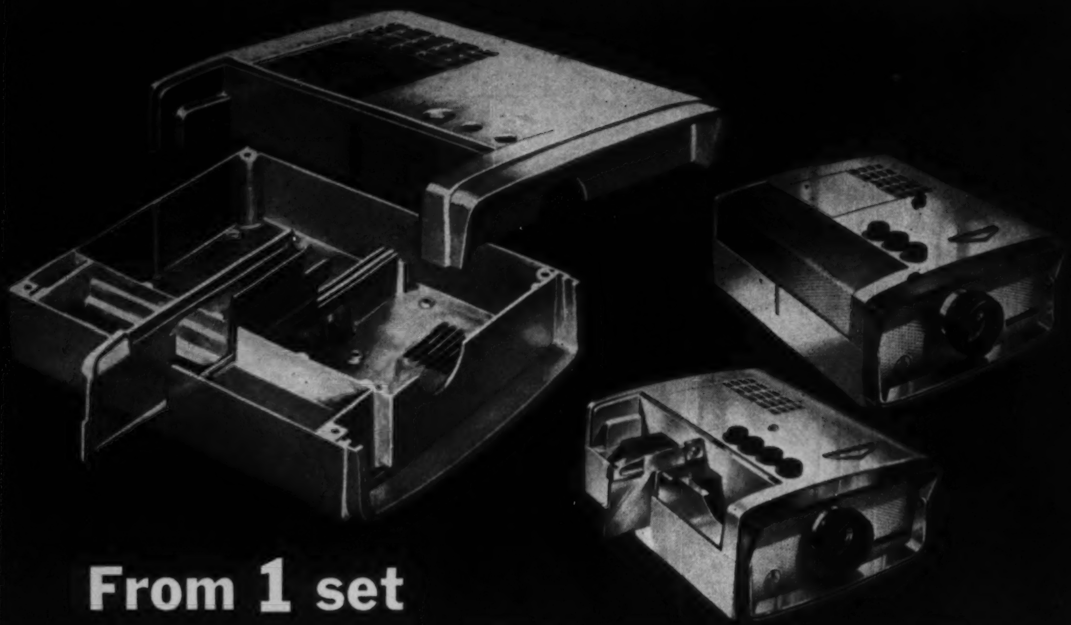
Contact your Louis Allis District Office or Distributor for complete information and engineering assistance. Or write for Bulletin 3300, The Louis Allis Co., 459 E. Stewart St., Milwaukee 1, Wis.

***ALLISPEDE is a trademark of The Louis Allis Co.*

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

Circle 476 on Page 19



From 1 set of die castings Brumberger makes 2 different products

CASE HISTORIES FROM
MT. VERNON FILES

If you like to project color transparencies, these two new automatic Brumberger* 35 mm, low silhouette, slide projectors will dazzle you. They are priced much lower than other automatic projectors and eliminate the additional expense of slide magazines and extra carrying case.

These are fine examples of keen engineering perception, for all the inherent advantages of die casting have been applied with those of metal stampings and plastics to produce competitively priced photographic products of outstanding eye appeal and performance.

As you can see, these aluminum die castings are intricate. All the necessary slots, channels, pins, gratings, bosses, holes, compartments, handle holes and various recesses are incorporated into the shells so that simple, rapid assembly and minimum finishing operations of the final product result.

Heat from the projection lamp will not warp or weaken the castings, and correct alignment of the optical system is maintained at all times by the thin but rigid, lightweight sections. For Brumberger, die casting has proved to be a supremely advantageous manufacturing method.

More than that, Brumberger has made full use of Mt. Vernons' complete four-fold service: coordinated designing, die making, casting and machining facilities all under one roof in 200,000 square feet of manufacturing space.

And when you plan to make a better product at lower cost by resorting to die castings, we can also give you invaluable help. Just call in your nearest Mt. Vernon sales representative for fast service.

*Brumberger — Brooklyn, N. Y.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

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Revolutionary New Flexible Metal Hose by BREEZE

(PATENTED)

Withstands New Highs in Pressures, Temperatures and Vibration

Where single convolution and synthetic tubing can't do the job, this all-metal hose, formed by BREEZE exclusive DOUBLE convoluting process will solve the most exacting high performance problems. Here are the advanced features:

1. **Excellent flow characteristics — low pressure drop.**
2. **Shorter bending radius — greater flexibility.**
3. **Double convolution design takes higher pressures, minimizes turbulence, absorbs vibration. No "set" due to misshaping of convolutions under high pressures, severe surges and pulsing.**
4. **All metal, high alloy 100% non-corrosive material. Withstands high temperatures where synthetics fail.**

Tell us your applications, requirements in pressures, temperatures, bend radius, inside diameters and usage (fuels, chemicals, oil, gas, etc.) We will fit this premium grade hose to your specific needs.

BREEZE
MARK

BREEZE

CORPORATIONS, INC.

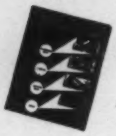
700 LIBERTY AVE., UNION, N.J.

BREEZE PRODUCTS: ACTUATORS • HOISTS • TRANSMISSIONS • GENERATORS • STARTERS
STARTER GENERATORS • BELLOWS • SLIP RINGS • HOSE CLAMPS • HITEMP FLEXIBLE TUBING
RADIO IGNITION SHIELDING • GROUND SUPPORT EQUIPMENT

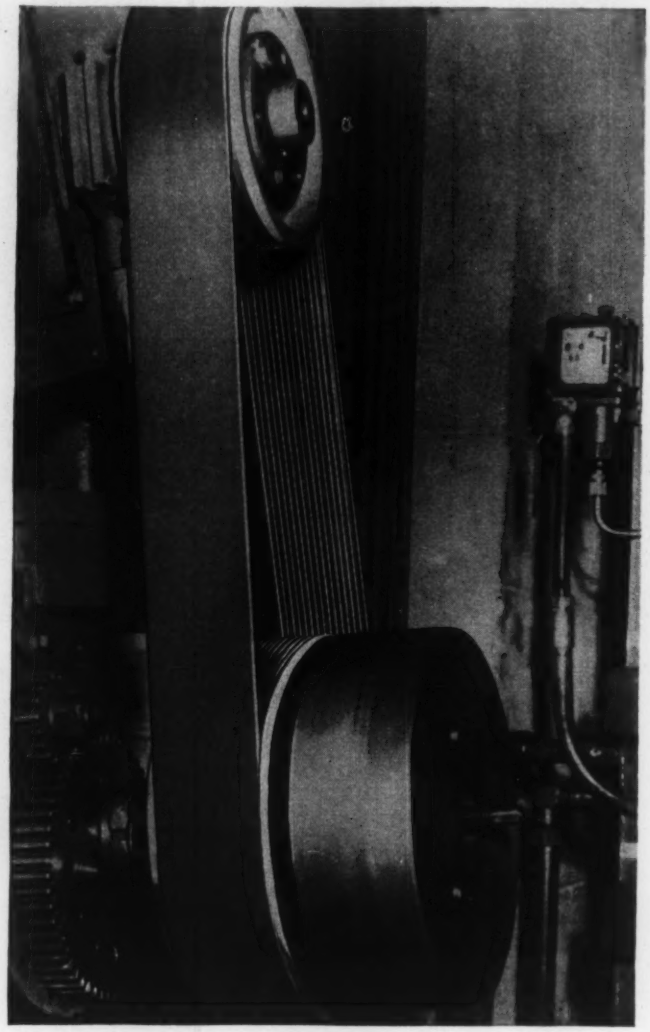
Circle 478 on Page 19

CUT COSTS, IMPROVE DESIGN AND PERFORMANCE WITH R/M PRODUCTS

RUBBER



Write today for free booklet shown: full details on a wide variety of industrial rubber products.
Manhattan Rubber Division, Raybestos-Manhattan, Inc.
Passaic, N.J.



R/M *Poly-V*® Drive

MORE POWER—LESS SPACE

Space saving advantages of R/M's patented Poly-V Drive has proved the answer to difficult drive problems for a wide range of applications. Use of Poly-V on this planetary milling machine, for example, almost *doubled* power capacity of the machine's drive . . . *without* increasing space requirements!

R/M Poly-V Drive employs a single, endless parallel V-ribbed belt running on sheaves designed to mate precisely with the belt ribs. Higher horsepower capacity per square inch of the single unit belt permits use of *narrower* sheaves. You get up to 50% *more* power in the *same* space as a standard multiple V-belt drive . . . or *equal* power in as little as ⅔ the space—with less shaft overhang, less drive weight.

Poly-V's single unit belt completely eliminates V-belt matching problems, helps assure constant pitch diameter and speed ratios from *no* load to *full* load. Stronger, cooler running, longer lasting Poly-V Belt is heat resistant, oilproof and non-spark. Just *two* cross sections of Poly-V Belt meet every heavy duty power transmission requirement. If you have a power transmission problem, let the R/M engineers who developed Poly-V* Drive assist you in determining the drive that will best meet your requirements. Write for Poly-V Bulletin 6638.

*Poly-V is a registered Raybestos-Manhattan trademark.

Wherever your problems require Poly-V* Drives, V-belts, flat transmission belting, conveyor belts, rubber hose, precision molded or extruded parts . . . rely on R/M specialists to work with you.

R/M

Brake Blocks, Linings and Clutch Facings

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

Circle 479 on Page 19

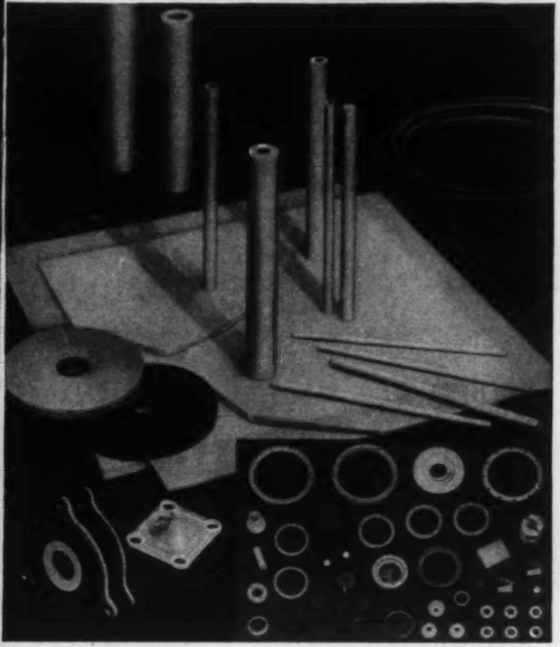
SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

PLASTICS

Write for free booklet, which provides valuable information on a variety of R/M plastic products.
Plastic Products Division, Raybestos-Manhattan, Inc.
Manheim, Pa.

PACKINGS

Complete information on packings shown and many others is given in free booklet. Send for it today.
Packing Division, Raybestos-Manhattan, Inc.
Passaic, N.J.



Typical R/M "Teflon" products—wire-braid hose, tape, sheets, tubes, rods, gaskets, expansion joints, etc.

Dependable quality in R/M TEFLON* parts and components

Our long experience and unparalleled facilities suggest Raybestos-Manhattan as your headquarters for any "Teflon" products you may need. R/M laboratories and engineers have had outstanding success in the developing and testing of "Teflon" products. This is matched by R/M's fabricating facilities and resourcefulness. We are constantly turning out those "can't be done" jobs.

We invite you to bring us your "Teflon" problems, especially those which involve close tolerances and intricate design. Whether your need is for steel wire-braid hose, custom-machined or molded parts or components, or applications using bondable "Teflon" sheet or tape, your specifications will be followed with painstaking accuracy. You may be able to use to advantage similar products made of Raylon, the R/M trade name for mechanical grade "Teflon" which has many of the properties of virgin "Teflon."

*A Du Pont trademark

R/M Piston Cups and Vee-Flex Packing Rings are among the many precision engineered R/M Packings

Get better performance from R/M Molded Packings

Accurate molding methods and precise quality controls assure you of outstanding performance when you specify molded hydraulic and pneumatic packings manufactured by Raybestos-Manhattan. Coupled with this is the extra benefit you get from the engineering skills and experience accumulated by R/M over many years as a leading manufacturer of mechanical packings. This advantage is demonstrated in such R/M products as piston cups and Vee-Flex® Rings.

R/M Piston Cups, available in Neoprene or Buna-N and duck or in Buna-N and asbestos. Compounds have been carefully developed by R/M's chemists to give maximum service for a wide range of applications. Low friction, high resistance to extrusion.

Vee-Flex Rings, made in five types, are self-sealing, self-adjusting. Designed to form a tight seal against stuffing box wall and shaft during pressure stroke and to reduce pressure on return stroke. Effective seal at all pressures.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C.
Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Rubber Lined and Covered Equipment | **Sintered Metal Friction Elements** | **Asbestos Textiles** | **Industrial Adhesives** | **Teflon Tape, Packings, Sheets, Rods, Tubes** | **Engineered Molded Rubber and Plastics**

Circle 480 on Page 19A

Circle 481 on Page 19A

A

new concept

to simplify your spring

design and purchasing problems

Select-A-Spring

ready-to-use engineered standard springs

Now you can select compression or extension springs from hundreds of ready-to-use, engineered standard-specification sizes. No fuss or paper work—no blueprints or drawings necessary. Select-A-Spring enables buyer or designer to pinpoint his needs without delay. Simply match your requirements to the Select-A-Spring list, order by catalog number, quantity and material. Especially convenient where quantities are moderate.

Select-A-Springs are pre-engineered, using wire certified to military and aircraft specifications, in various lengths, diameters, rates, and loads up to 20 lb. They meet industry and military standards. Material is either music wire or stainless steel. Compression springs are squared and ground. Extension springs have regular loops. Other ends and loops optional.

Whether your need is immediate or future, write now for the A.S.C. Select-A-Spring list. Keep it handy as a time-saving, useful spring service.

Associated Spring Corporation General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
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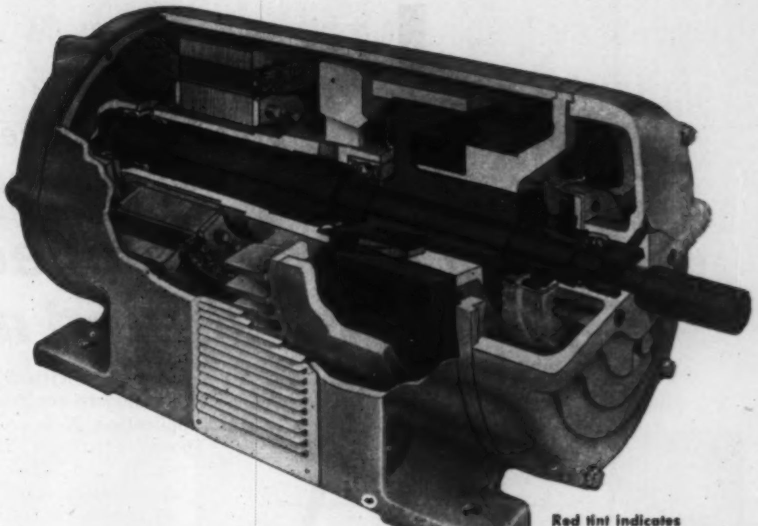
Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

5907

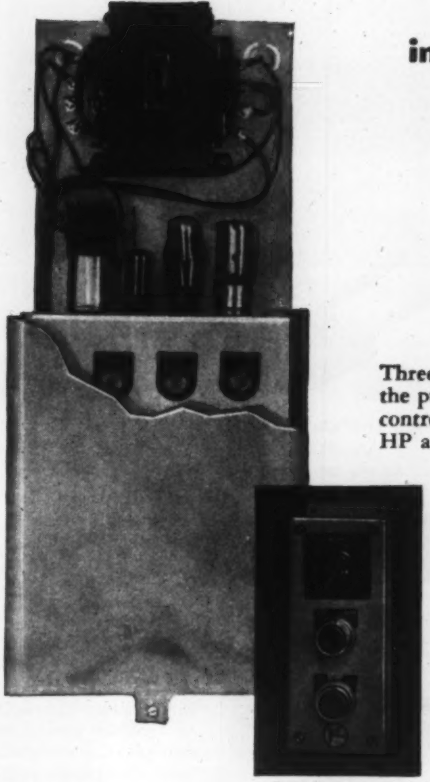
THIS NEW QUILL-TYPE AJUSTO-SPEDE® DRIVE

Plus

THIS NEW K-2 CONTROL and PUSH-BUTTON STATION



Red tint indicates adjustable speed member.



Give You Controlled Adjustable Speed from an AC Power Source

in a Compact, Low Cost 3-Unit Drive Package

by

DYNAMATIC®

PIONEER IN EDDY-CURRENT EQUIPMENT

Three compact components, the Ajusto-Spede Drive, the K-2 Control, and the push-button station make up this complete drive package which provides controlled adjustable speeds for any application from ½ HP through 7½ HP at 1800 RPM.

Remote wall mounting of the control panel conserves space on the driven machine; the push-button station places vital controls at the operator's finger tips.

Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control by the installation of a single resin-encapsulated circuit.

Send for complete information covering design and operation of the new models ACM-903 and 904 Ajusto-Spede Drives. Read how the new K-2 Control provides infinite speed adjustment, on-off clutch control, constant speed control, jogging, threading, cascading, and acceleration control.

Our New Bulletin K-2-159 is Now Available.

EATON®

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

←Circle 482 on Page 19

Circle 483 on Page 19

precision engineered
control switches

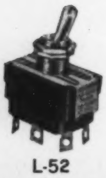
designed with brand new features

Keeping pace with design engineers, Circle F offers modern control switches for every possible application. New economies are now possible through the use of standard switches readily modified to meet any particular specification. Circle F's advanced standards of quality-controlled manufacture makes possible assembly-line production of highest quality "custom-made" switches in less time and at lowest costs. Whatever your need, write Department S for fullest information and helpful engineering assistance.

M-1886-L4P
NEW "PADDLE" HANDLE SWITCH

1885-6
NEW THREADED PLUNGER SWITCH
for any cap

L-40



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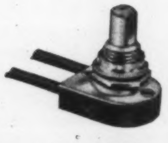


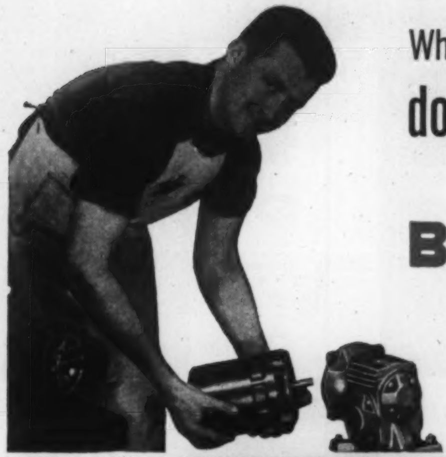
1885

1903

CIRCLE F's "Fine" Silver Contacts reduce arcing on slow-make, slow-break AC and insure long, dependable switch life.

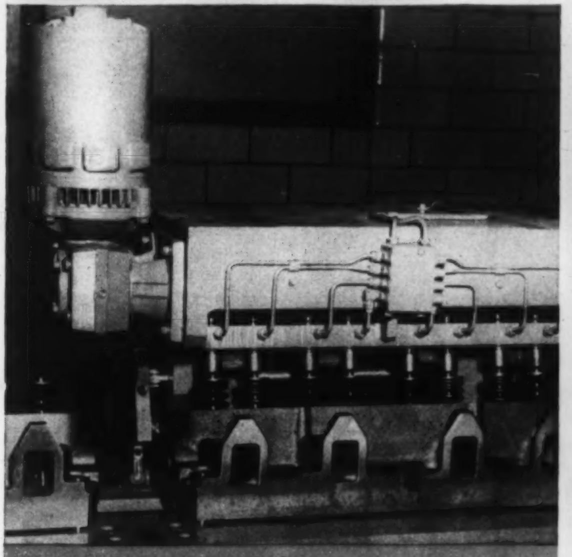
CIRCLE F MFG. CO.

TRENTON 4, NEW JERSEY • For your wire requirements: Eastern Insulated Wire Corp., Box 591, Trenton, N. J.



Where continuous automatic operations demand
double insurance against downtime
the leading choice is standardized
BOSTON Gear® SPEED REDUCERS

NO DOWNTIME for motor repairs. The standard end-mounted motor on BOSTON Gear RATIOMOTORS is easily detached by removing the bolts holding the motor to the gear unit flange. A spare motor can be attached, and operations resumed in a *few minutes.* Gear unit remains undisturbed, preserving alignment.



BOSTON Gear Vertical Right Angle RATIOMOTOR drives the valve "popping" (final test) unit in a giant 29-station transfer machine for continuous automatic assembly of cylinder heads.

BOSTON Gear Horizontal Right Angle RATIOMOTORS drive magnetic belts which convey parts from lower storage bins to vibratory hoppers at start of 13-station, automatic assembly of roller skate wheels.

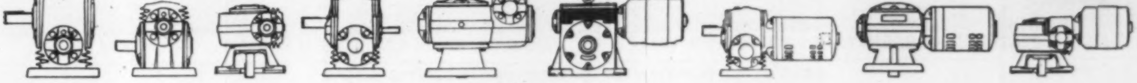
BOSTON Gear RATIOMOTORS are the leading choice for all types of installations where downtime would be disastrous to production schedules. One reason is BOSTON Gear quality standards, which assure highest efficiency and extra service life of the gear unit. Another is BOSTON Gear design leadership like the detachable motor which permits continued operation with a spare, avoids downtime. Design around BOSTON Gear RATIOMOTORS for this *double* insurance against downtime. All types and ratios are *standardized stock* models, quickly available anywhere from over 100 BOSTON Gear Distributors. Boston Gear Works, 64 Hayward Street, Quincy 71, Massachusetts.

Advt. copyright by Boston Gear Works

FROM STOCK!
AT YOUR NEARBY BOSTON Gear DISTRIBUTOR
— *STANDARDIZATION PAYS* —®

For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

REDUCTORS — RATIOMOTORS — FLANGED REDUCTORS — Catalog lists 1605 types and ratios



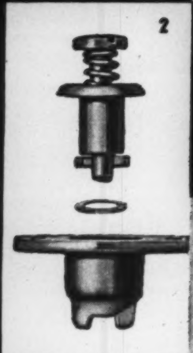
Circle 485 on Page 19

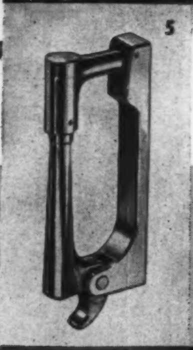
specialists in fasteners for industry

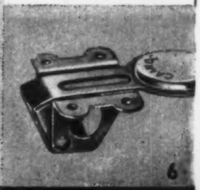
speed · versatility · positive performance

Outstanding creative engineering at Camloc has produced a variety of fastening devices. For access panels, doors, other closures, for simplified replacement of components and sub-assemblies. There are other fastening devices, designed for a variety of specialized applications, all of them retaining the three important features that characterize all Camloc products: . . speed, versatility and positive performance.

CAMLOC

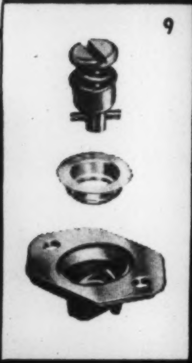


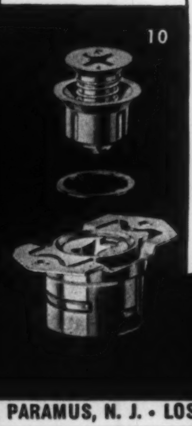




1. 5F fastener for thin materials
2. 2600 Series Quarter-Turn
3. Miniature Toggle Tension Latch
4. 91F Heavy Duty Quarter-Turn
5. Electronic Chassis Latch
6. Push Button Latch
7. 28F Series Quarter-Turn
8. 7C Harness Clamp
9. 4002 Series Quarter-Turn
10. SPF (Stressed Panel Fastener)

JUST OFF THE PRESS...
The new Condensed
Catalog No. 59.
Write for your
free copy now.



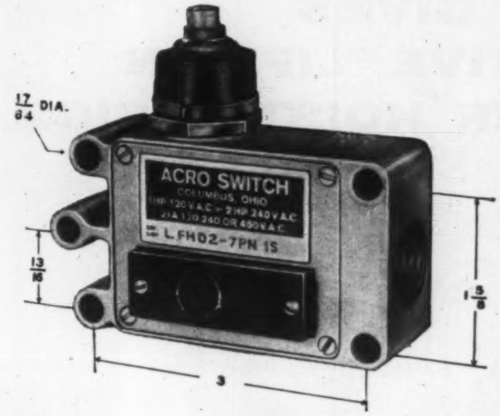


CAMLOC FASTENER CORPORATION • 37 SPRING VALLEY RD., PARAMUS, N. J. • LOS ANGELES, CALIF. • FT. WORTH, TEXAS

VISIT US AT BOOTH 1124, DESIGN ENGINEERING SHOW

Circle 486 on Page 19

What's new in Acro's metal-clad switches? *It's Acro Lite.....with a Visual Indicator Directly on the Switch!*



NEW! Acro's "20th Anniversary" Acro-Lite Acts as a VISUAL INDICATOR on the Switch!

FEATURES:
- Switching unit is replaceable without removing housing from its mounting
- Choice of five different actuators
- Mounting is optional through any of the five mounting holes provided
- Contact arrangement: single pole double throw. Internal switch has screw terminals
- High capacity. Internal switch U.L. approved for 21 amperes at 120, 240, and 480 V.A.C. Also approved 1 HP-115 V.A.C., 2 HP-240 V.A.C.

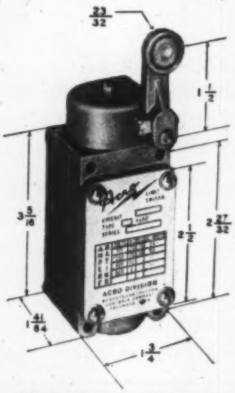
This year — Acro's 20th — introduces ACRO-LITE — a brand new feature that gives your customers visual evidence of performance — directly on the switch! If you specify metal-clad switches in your product line, direct your purchase inquiry to Acro Switch. For Acro makes a complete, reliable line of metal-enclosed switches — that fill your needs for protective housings, with either side or flange mount casings.

When Acro-Lite is Lit – the Switch is Powered!

This visual indicator panel consists of a neon light, built directly into the side of the switch. When the light is on, there's power flowing through the switch. Or, if your product construction hides the switch from direct view — the light can be mounted remotely for easy visibility. Acro-lite offers high current ratings — 21 Amps — up to 2 HP.

Switching unit completely enclosed in sturdy, lightweight aluminum. Rubber gaskets on all removable parts of the housing. Neoprene boot seals the overtravel plunger, making the switch dust - and splash-proof; assures continuity of repetition patterns. Connecting conduit (switch housing is internally tapped for ½" conduit) completes the seal. Light operating pressures, with close movement differential.

Acro's Small Sized Machine Tool Switch Handles Heavy Load



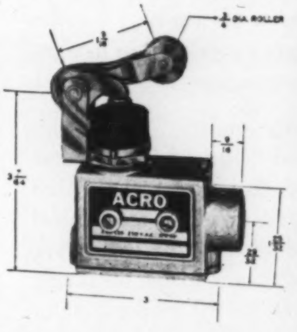
ELECTRICAL RATING
2 H.P. 230 Volts A.C.
1 H.P. 115 Volts A.C.
20 Amps-250 Volts A.C.

Controls up to four separate circuits for either pilot or line duty. Perfect for machine tool and all production machinery applications. Actuator is adjustable 360° in two planes. Basic switch is easily replaced. Dust-and oil-tight, long mechanical life, long overtravel. Meets NEMA and JIC requirements.

Available in Two Types

Double Action Type actuates switch contacts when actuator is moved either side of "at rest" position. Single Action Type operates from one side of "at rest" position only. Both designed for long life under heavy use.

Acro's Model "F" Enclosed Switches Have Exceptionally High Capacity



HIGH ELECTRICAL RATING
2 H.P. 240 V.A.C.
1 H.P. 115 V.A.C.
21 Amps @ 120, 240 or 480 V.A.C.

Acro features a complete line of enclosed switches with many different actuators and styles available. Dust and oil type enclosure, with side or flange mounting. Replacement switch kit is available.

Underwriters Laboratory approved

Write for more detailed information on ACRO's metal enclosed switches and take advantage of our free engineering service. We'll be happy to go to work on your specific application problem. District offices located in principal cities.

RELAYS
ACRO
SWITCHES
"OUR 20th YEAR"

MR. CONTROLS

ACRO DIVISION Robertshaw-Fulton CONTROLS CO.
COLUMBUS 16, OHIO
Manufacturers of a complete line of load-tested precision snap-switches and relays.

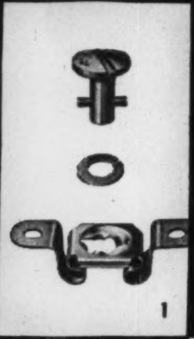
Circle 487 on Page 19

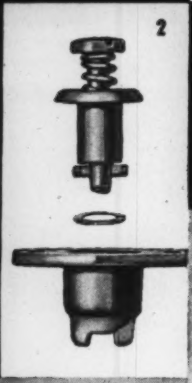
specialists in fasteners for industry

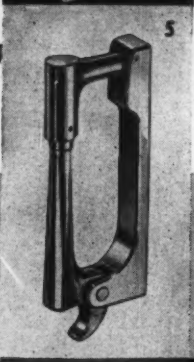
speed · versatility · positive performance

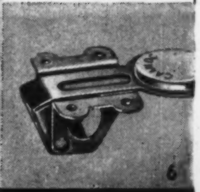
Outstanding creative engineering at Camloc has produced a variety of fastening devices. For access panels, doors, other closures, for simplified replacement of components and sub-assemblies. There are other fastening devices, designed for a variety of specialized applications, all of them retaining the three important features that characterize all Camloc products . . . speed, versatility and positive performance.

CAMLOC









1. 5F fastener for thin materials
2. 2600 Series Quarter-Turn
3. Miniature Toggle Tension Latch
4. 91F Heavy Duty Quarter-Turn
5. Electronic Chassis Latch
6. Push Button Latch
7. 28F Series Quarter-Turn
8. 7C Harness Clamp
9. 4002 Series Quarter-Turn
10. SPF (Stressed Panel Fastener)

JUST OFF THE PRESS...
The new Condensed
Catalog No. 59.
Write for your
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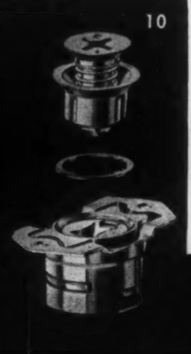
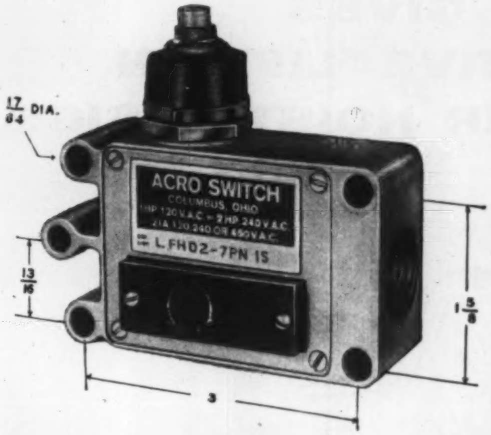


CAMLOC FASTENER CORPORATION • 37 SPRING VALLEY RD., PARAMUS, N. J. • LOS ANGELES, CALIF. • FT. WORTH, TEXAS

VISIT US AT BOOTH 1124, DESIGN ENGINEERING SHOW

Circle 486 on Page 19

What's new in Acro's metal-clad switches? *It's Acro Lite.....with a Visual Indicator Directly on the Switch!*



This year — Acro's 20th — introduces ACRO-LITE — a brand new feature that gives your customers visual evidence of performance — directly on the switch! If you specify metal-clad switches in your product line, direct your purchase inquiry to Acro Switch. For Acro makes a complete, reliable line of metal-enclosed switches — that fill your needs for protective housings, with either side or flange mount casings.

When Acro-Lite is Lit – the Switch is Powered!

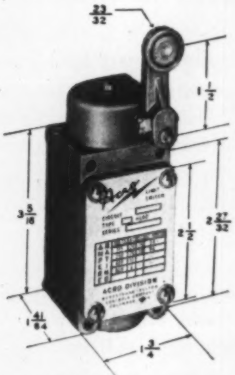
This visual indicator panel consists of a neon light, built directly into the side of the switch. When the light is on, there's power flowing through the switch. Or, if your product construction hides the switch from direct view — the light can be mounted remotely for easy visibility. Acro-lite offers high current ratings — 21 Amps — up to 2 HP.

Switching unit completely enclosed in sturdy, lightweight aluminum. Rubber gaskets on all removable parts of the housing. Neoprene boot seals the overtravel plunger, making the switch dust - and splash-proof; assures continuity of repetition patterns. Connecting conduit (switch housing is internally tapped for ½″ conduit) completes the seal. Light operating pressures, with close movement differential.

NEW! Acro's "20th Anniversary" Acro-Lite Acts as a VISUAL INDICATOR on the Switch!

FEATURES:
- Switching unit is replaceable without removing housing from its mounting
- Choice of five different actuators
- Mounting is optional through any of the five mounting holes provided
- Contact arrangement: single pole double throw. Internal switch has screw terminals
- High capacity. Internal switch U.L. approved for 21 amperes at 120, 240, and 480 V.A.C. Also approved 1 HP-115 V.A.C., 2 HP-240 V.A.C.

Acro's Small Sized Machine Tool Switch Handles Heavy Load



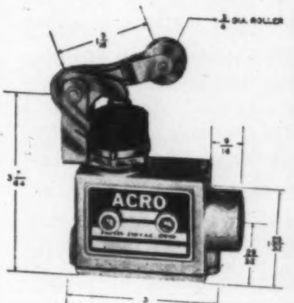
ELECTRICAL RATING
2 H.P. 230 Volts A.C.
1 H.P. 115 Volts A.C.
20 Amps-250 Volts A.C.

Controls up to four separate circuits for either pilot or line duty. Perfect for machine tool and all production machinery applications. Actuator is adjustable 360° in two planes. Basic switch is easily replaced. Dust-and oil-tight, long mechanical life, long overtravel. Meets NEMA and JIC requirements.

Available in Two Types

Double Action Type actuates switch contacts when actuator is moved either side of "at rest" position. Single Action Type operates from one side of "at rest" position only. Both designed for long life under heavy use.

Acro's Model "F" Enclosed Switches Have Exceptionally High Capacity



HIGH ELECTRICAL RATING
2 H.P. 240 V.A.C.
1 H.P. 115 V.A.C.
21 Amps @ 120, 240 or 480 V.A.C.

Acro features a complete line of enclosed switches with many different actuators and styles available. Dust and oil type enclosure, with side or flange mounting. Replacement switch kit is available.

Underwriters Laboratory approved

Write for more detailed information on ACRO's metal enclosed switches and take advantage of our free engineering service. We'll be happy to go to work on your specific application problem. District offices located in principal cities.

RELAYS
ACRO
SWITCHES

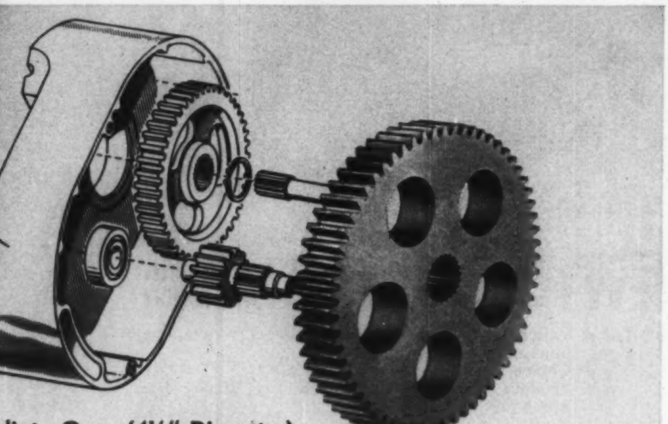
"OUR 20th YEAR"

MR. CONTROLS

ACRO DIVISION Robertshaw-Fulton CONTROLS CO.
COLUMBUS 16, OHIO
Manufacturers of a complete line of load-tested precision snap-switches and relays.

Circle 487 on Page 19

OILITE
GEAR GIVES
POSITIVE "LIFT" IN
POWER HOIST DESIGN



Super Oilite #9 Intermediate Gear (4½" Diameter)

...saves Chisholm-Moore 53¢ per unit

You can be sure this heavy-duty "Lodestar" hoist is a rugged performer capable of handling loads quickly, efficiently . . . the result of CM's 70 years experience in designing and manufacturing hoists for industry!

Only top quality parts qualify. That's why CM engineers specified "Oilite"® for the vital intermediate gear of the train. The Oilite Precision Part provided excellent mechanical properties, close tolerances and fine surface finish. Consequently, gears made of tough, wear-resistant Super Oilite #9 transmit motor power smoothly and quietly . . . have more than enough mechanical strength to assure long, trouble-free life.

Moreover, the Oilite gear is produced as a finished part requiring no machining . . . saving CM *53c on every gear used!* Chrysler-engineered Oilite Precision Parts are obtainable in many metals and alloys to give desired mechanical properties. Savings up to 55% or more are common for parts produced in volume.

Contact your local Oilite Engineer for possible savings on your parts. Look for him in the Yellow Pages under "Bearings—Oilite" or write Dept. S-5.

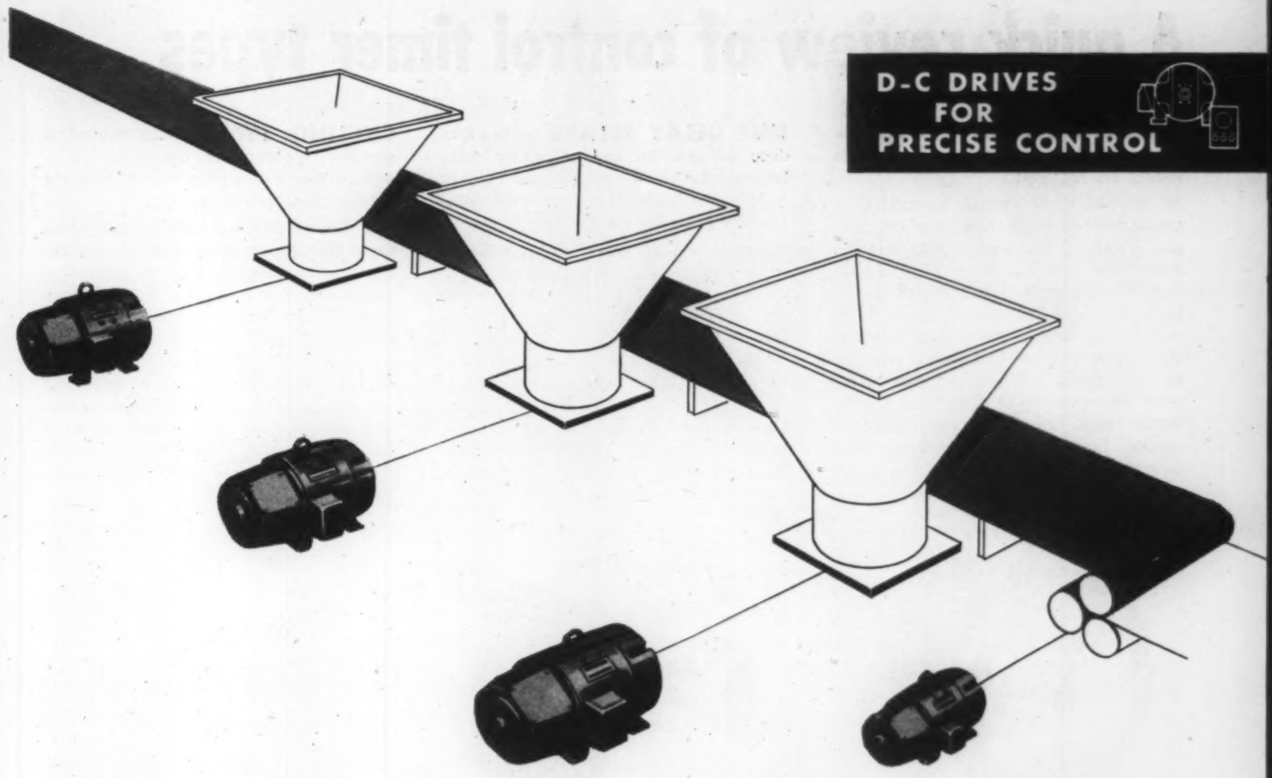
® Only Chrysler Makes Oilite

SINCE 1929 A CHRYSLER OILITE PRODUCT

the most trusted name in powder metallurgy!

AMPLEX DIVISION
CHRYSLER CORPORATION, DETROIT 31, MICHIGAN
SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

D-C DRIVES FOR PRECISE CONTROL



Problem: How to control machine speed ratios for accurate proportioning, continuous flow

Keeping the blend accurate in proportionate mixing requires a high degree of machine coordination. Inaccurate speed matching of mixers or conveyors can result in poor product quality, inaccurate measure, wasted material.

ACCURATE SPEED MATCHING IS A NATURAL JOB FOR DIRECT-CURRENT POWER. For only direct current can provide the split-second response, wide speed range and precise control vital to modern, automatic machines.

If you are planning to upgrade your production facilities to make processes more automatic, it will pay you to investigate the role direct current can play. A new booklet, "WHY D-C?," is available to help you. For your free copy, write *Section 829-2, General Electric Company, Schenectady 5, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

SELECT FROM GENERAL ELECTRIC'S COMPLETE LINE OF D-C DRIVES

MOTORS AND GENERATORS

POWER UNITS AND CONTROLS

Circle 489 on Page 19

A quick review of control timer types . . .

INTERVAL TIMERS — *for accurate time control where frequent changes in setting are required.*

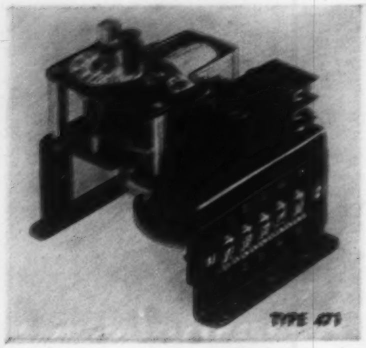
An interval timer consists basically of a constant-speed motor, an arm or cam, and a switch. The user simply sets the mechanism manually to the desired time interval. This action transfers switch contacts that start the timer motor. The motor then drives the arm or cam to the set point, where the switch is returned to its original position and the motor shuts off. A variety of dials, knobs, push-button start, automatic reset features, special housings and additional load switches may be used, but the basic operation is the same in all cases.

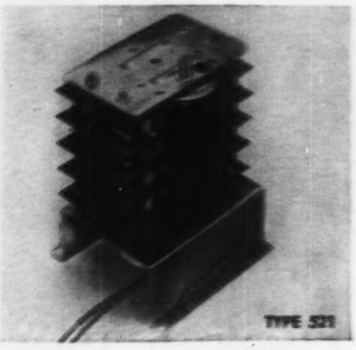
TIME DELAY RELAYS — to introduce an accurate and adjustable delay between the closing of a control circuit and the actuation of one or more independent load switches.

Again, a constant-speed motor drives a set of precision-cut cams from an adjustable starting point to a later point where one or more load switches are transferred. The unit continues to the end of its cycle, at which point the motor shuts off and the timer remains "timed out" until it is reset. Optional automatic reset, various clutching devices, and a wide selection of wiring arrangements make the time delay relay a highly versatile control with countless uses.

CYCLING TIMERS—to control a repeated sequence of operations in a definite time relationship which does not require frequent change.

The basic difference between a cycling timer and a time delay relay is that the cycling timer continues to run, cycle after cycle, until it is shut off. The single-pole double-throw load switches are transferred back and forth, at exactly determined times, by cams fixed to the motor shaft. Multiple load switches, an almost endless number of cam combinations, excellent accuracy, and a wide range of basic cycle speeds make the cycling timer an ideal program-control device in many processes.





. . . you can choose at a glance from this table

CLASS	INTERVAL TIMERS		TIME DELAY RELAYS					CYCLING TIMERS	
CRAMER TYPE	241	271	310	330	440A	412	471	511-21	571
Time Ranges	6 s to 24 h	45 s to 24 h	15 s to 120 s	20 s to 80 s	15 s to 3 h	6 s to 24 h	15 s to 24 h	6 s to 48 h	60 s to 3 h
Load Switches (SPDT)	1	1 or 2	1	1 or 2	1 to 5	1	1 or 2	1 to 8	1 to 4
Automatic Reset	Yes	No	Yes	Yes	Yes	Yes	Yes	—	—
Repeat Accuracy (% of total range)	¼%	½%*	½%	¾%	½%	¼%	2%	½%	1½%
Progress Indication	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Adjustable	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Operated by:									
Momentary contact	No	No	No	No	Yes	Yes	Yes	No	No
Sustained contact	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mounting	Panel	Back Panel	Panel	Surface	Surface	Panel	Surface	Surface	Surface
Unit List Price	$24.00	$ 8.00 or $10.00	$27.00	$18.00 or $23.00	$42.00 to $66.00	$42.00	$23.50 or $27.50	$16.00 to $44.00	$ 8.50 to $11.50
Motor & clutch rating	All standard voltages in 50, 60 and 400 cps AC, and in DC								

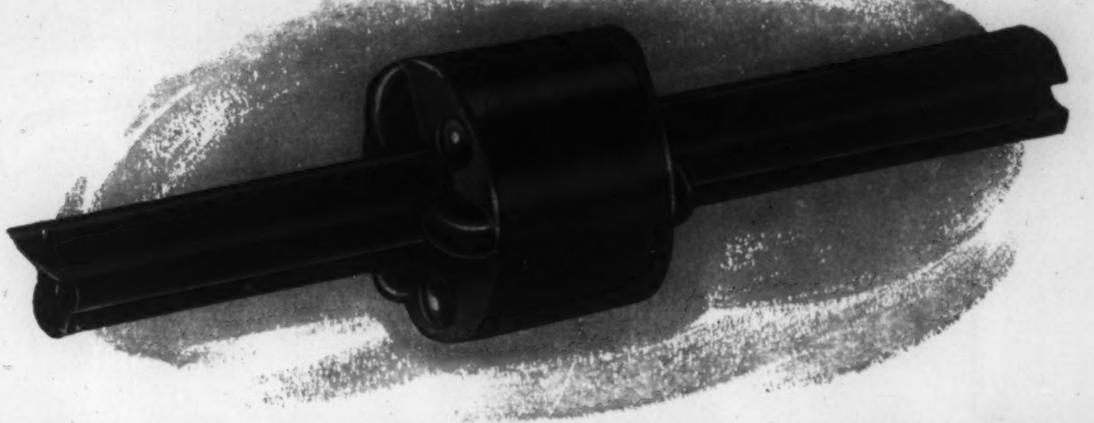
**Exclusive of human setting error*

LEARN MORE about these and other basic timing devices from Cramer's complete line. Write for free bulletins on the types that interest you — or describe your problem and let us help you solve it.

CRAMER CONTROLS
CORPORATION
Box 6, Centerbrook, Connecticut

Circle 490 on Page 19

SAGINAW ANNOUNCES



A NEW SERIES OF STANDARD b/b SPLINES
AT LESS THAN HALF FORMER COST!

Average 40 TIMES Lower Coefficient of Friction than Conventional Sliding Splines—Far Better Performance at Comparable Cost

Good news for machine tool, aircraft and other designers! Standardization and volume production economies now enable you to take full advantage of this revolutionary ball/bearing Spline, built on the same gliding ball principle pioneered by the famous Saginaw b/b Screw.

Wherever easy linear movement is required under high torque load, Saginaw Standard b/b Splines offer:

- *Freedom from Frictional Heat* • *Minimum Radial Lash*
- *Long, Trouble-free Service Life*

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These new low-cost Standard b/b Splines are high commercial quality with excellent precision and service life, suitable for all but the most critical applications. Yet they cost about the same as high-friction splines.

TRANSMIT OR RESTRAIN HIGH TORQUE LOADS NO OTHER SPLINE CAN HANDLE

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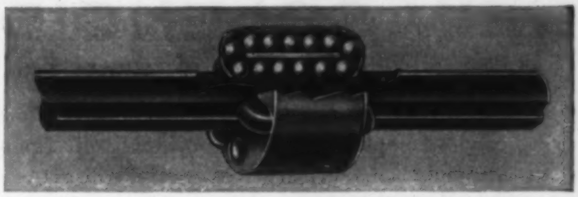

Saginaw b/b Splines transmit or restrain high torque loads with far less friction because mating surfaces *glide* on rolling balls instead of *sliding* back and forth. Steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of inner and outer parts.

6 STANDARD SIZES

.375 .625 1.000 1.500 2.000 2.500

Can be fitted with integral gears, clutch dogs, bearing and sprocket seats or other attachments for use with electrical, hydraulic or pneumatic units.

SEND TODAY FOR FREE BALL BEARING SCREW AND SPLINE HANDBOOK

or see our section in Sweet's Product Design file.

Saginaw ball/bearing Screws & Splines

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN

WORLD'S LARGEST PRODUCER OF BALL/BEARING SCREWS AND SPLINES

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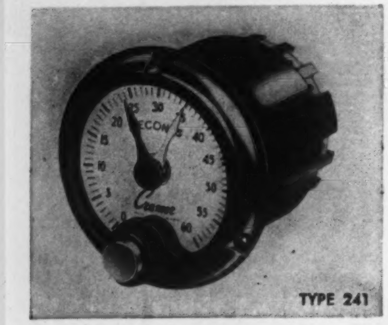
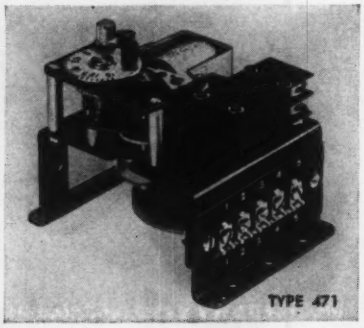
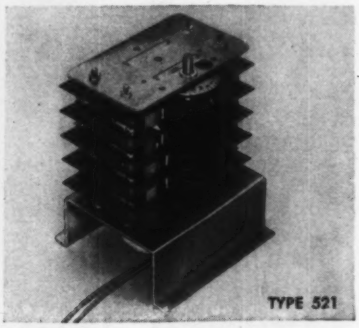

TYPE 241


TYPE 471


TYPE 521

. . . you can choose at a glance from this table

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Progress Indication	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Adjustable	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Operated by:									
Momentary contact	No	No	No	No	Yes	Yes	Yes	No	No
Sustained contact	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mounting	Panel	Back Panel	Panel	Surface	Surface	Panel	Surface	Surface	Surface
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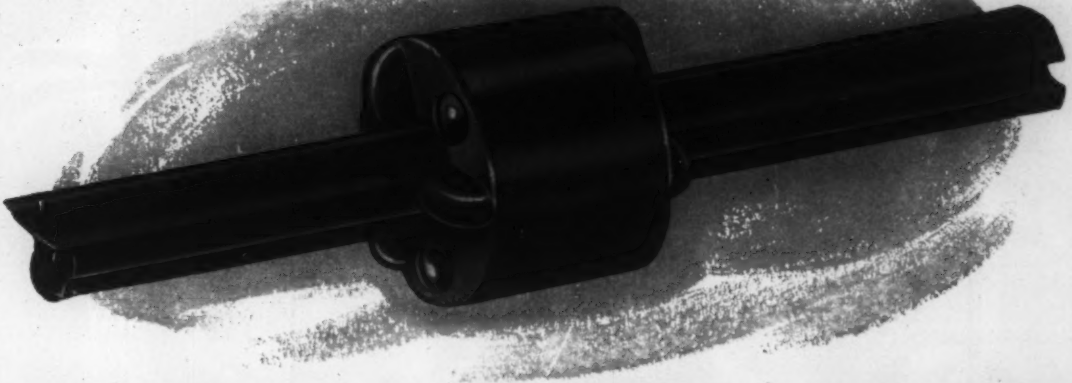
CRAMER CONTROLS
CORPORATION
Box 6, Centerbrook, Connecticut

Circle 490 on Page 19

SAGINAW ANNOUNCES



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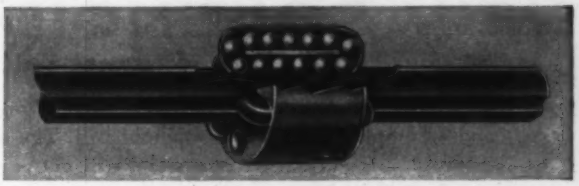

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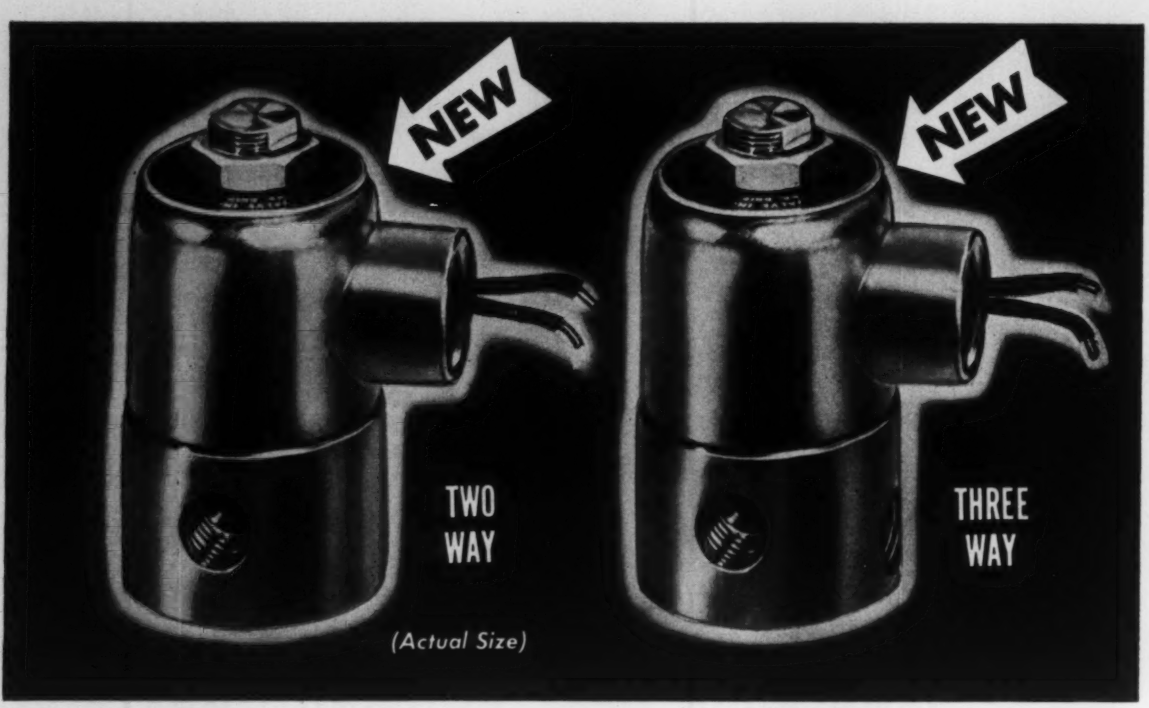


(Actual Size)

NEW SOLENOID VALVES *by* Airmatic

These corrosion-proof valves have only one internal moving part and a completely protected solenoid coil. The coil is fully sealed from air, oil, gas and water . . . and will not overheat on continuous duty. Coils for continuous or intermittent duty, a-c or d-c, are interchangeable.

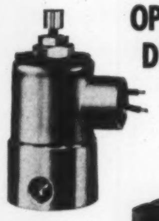
Life expectancy is many millions of cycles and by renewing the one-piece valve plunger, many millions more can be expected. The plunger can be replaced without disturbing rigid piping.

DISTRIBUTORSHIPS FOR THESE NEW VALVES ARE AVAILABLE

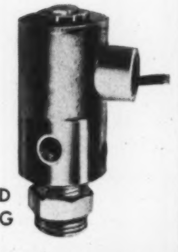
SPECIFICATIONS

	TWO-WAY	THREE-WAY
CATALOG NO.	91011	91011
PRESSURE RANGE	1/16″ ORIFICE: 0-500 PSI 3/16″ ORIFICE: 0- 70 PSI	1/8″ ORIFICE: 0-300 PSI 3/16″ ORIFICE: 0-100 PSI
ORIFICES	1/16″ THROUGH 3/16″	1/8″ AND 3/16″
VOLTAGE	MOST A-C AND D-C	MOST A-C AND D-C
DUTY	CONTINUOUS	CONTINUOUS
POWER CONSUMPTION	10 - 20 WATTS	10 - 20 WATTS
HEAT RISE	WITHIN UL LIMITS	WITHIN UL LIMITS

OPTIONAL DESIGNS

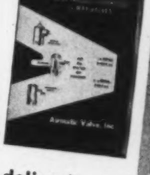


MANUAL OVER-RIDE



MANIFOLD MOUNTING

ASK FOR CATALOG



All valve deliveries are made from stock.

AIRMATIC VALVE, Inc.

7313 Associate Avenue • Cleveland 9, Ohio

EVERYTHING UNDER CONTROL

Phone: WOodbine 1-5320 • WESTERN UNION: Airmatic Valve, Inc., FAX, Cleveland, Ohio

Circle 491 on Page 19

ISSUE NO. 9

the neg'ator® *sketchbook*

The NEG'ATOR® Spring is a new basic mechanical component—a coiled band spring which extends many times its original size without the increasing force common to conventional springs. Used as an extension spring, a motor, band, clamp, or clip, this revolutionary new constant-force component upsets all previous spring principles by doing what springs have never done before.

NEG'ATOR® COILS USED AS CLIPS, BANDS, OR TUBES OFFER A UNIQUE COMBINATION OF PROPERTIES

NEG'ATOR clips, bands, and tubes are made from the basic NEG'ATOR coiled unit which can be high strength stainless steel, high carbon steel or, sometimes, other alloys. They can be cut to provide any portion of a circle, practically any length tube, or long lengths for applications as bands.

Used as clips, bands, tubes, NEG'ATOR components provide unusual advantages. For example, a NEG'ATOR

. . . can be straightened completely without exhibiting permanent set.

. . . can be wrapped into place when it consists of several turns of over-wrapped material.

. . . offers excellent dimensional control through methods of manufacture.

. . . provides great strength when made of material much thinner than conventional clips, tubes, bands.

. . . can be made very wide when applications demand.

. . . gives space relief because it is flat and thin.

. . . is economical, requires no hardening, is formed simply.

. . . can be made tough or flimsy, bright or dark, magnetic or not, and can be pierced, notched, or shaped on the ends to meet requirements.

Currently, NEG'ATOR clips, bands, or tubes are being used as lubrication packings, protective shields, retainer rings, guides, drums, mechanical locks, hinges, electrical contacts, arming devices for missiles, pressure applicators, masks, closures, and in many other ways. Several typical applications are described on this and the reverse page.

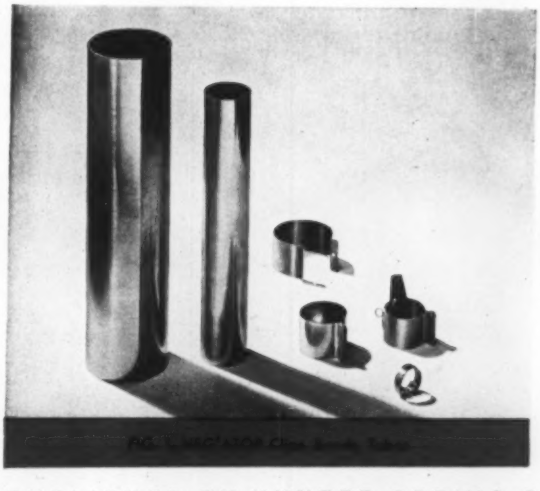


FIG. 1. NEG'ATOR Clips, Bands, Tubes

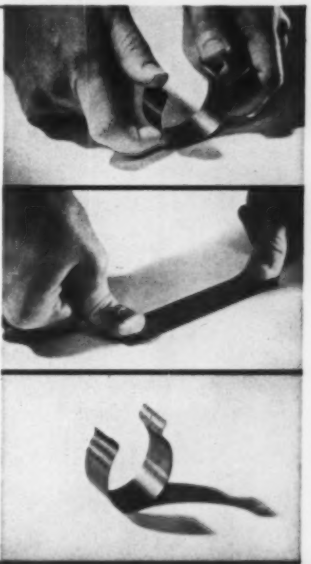


FIG. 2. NEG'ATOR Clips retain their toughness and elasticity where conventional spring clips would become distorted (take a set). In many of its present applications, the NEG'ATOR Clip is snapped onto a shaft or similar member where access, by way of the shaft ends, is not possible or practical. The clip must then be opened wide and slipped over the diameter. NEG'ATOR Clips can be straightened without becoming distorted and are therefore ideal for such applications.

From a complete circle . . . a NEG'ATOR Clip can be flattened . . . and will return to its original shape.

NEG'ATOR CLIP ACTS AS RETAINING BAND

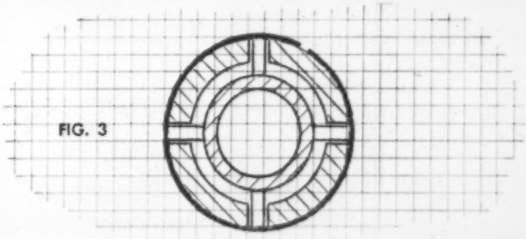


FIG. 3

In Fig. 3, a plain NEG'ATOR Clip is used as a retaining band. The highly-stressed band holds pins in the proper position to center a cylinder in a fire pump chamber. The characteristics of the NEG'ATOR Clip make it easy to apply and to remove without impairing its tight-clasping characteristics. Many NEG'ATOR Clips are used for applications similar to this where "wide opening without deformation" characteristics are important.

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A Division of American Machine and Metals, Inc.

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SAFETY CLIP FOR REPEATED USE

A NEG'ATOR Clip of the type shown in Fig. 4 is used to lock tube junctions on construction scaffolding. A hole in one tube is aligned with a corresponding hole in the tube to be joined. The pin of the clip is inserted through both holes, locking the tubes in position. Ordinary clips became "tired" after several applications, lost their firm gripping strength because forcing them wide open permanently deformed them. Pre-stressed NEG'ATOR Clips don't relax, no matter how wide they are opened.

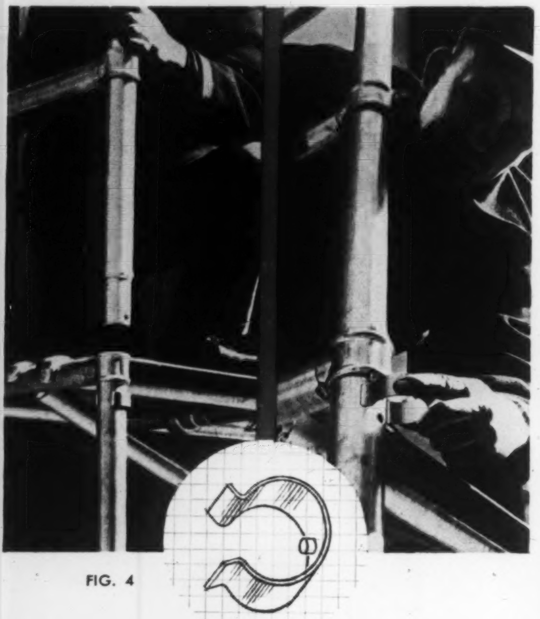
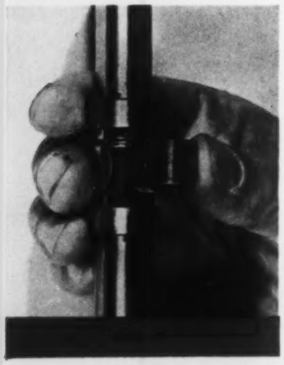


FIG. 4

"WRAP-AROUND" NEG'ATOR CLIP LOCKS ELECTRICAL CONNECTORS



In Fig. 5, a "wrap-around" clip is used to lock coaxial electrical connectors in place. NEG'ATOR Clips are ideal for this purpose because they can be applied without disconnecting the two members. Installation is quick. The clip is rolled around the mated connectors easily without being the least bit reshaped. Once mounted, the clip holds tightly to the connectors.

NEG'ATOR BAND USED AS DRUM ON RECORDER

Used in the form of a band 4-in. in diameter, 11-in. wide, and .010-in. thick, the NEG'ATOR Spring shown in Fig. 6 acts as a drum on a recorder. Used in this manner, the band can be opened wide to install. Being flat and thin, it is light in weight yet offers great strength. The surface is hard, smooth and dimensionally accurate.

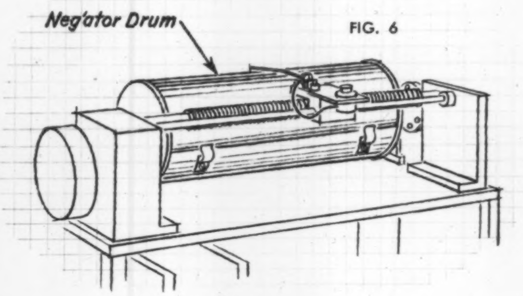


FIG. 6

OTHER NEG'ATOR SHAPES

LOCK: A NEG'ATOR Clip is used as a locking clip to prevent accidental arming of a projectile during handling and storage. In assembly, it is necessary that the clip be forced over the full diameter to mount over the mating parts. The clip must also be able to stand definite torque loading without breaking. Out of more than a dozen sources tried, only the NEG'ATOR Clip proved to be satisfactory for close fit, firm grip and instant removal when needed.

* * * * * * *

FRICTION MEMBER: A manufacturer of telescoping lamps and ash trays uses NEG'ATOR Clips as friction members in both products. The firm gripping characteristics of these clips even when made from thin material is important in this application.

* * * * * * *

PROTECTIVE WRAPPER: A different form of NEG'ATOR is shown in the small drawing. A basic NEG'ATOR coil, made from thin material, can be wrapped around cylindrical objects as a protective wrapper which can be easily applied, easily removed, and reused as many times as desired. When wrapped around a tube with a diameter larger than the inherent NEG'ATOR diameter, the band will grip the wrapped object tightly, thus forming a protective metal coating and providing a high degree of rigidity.

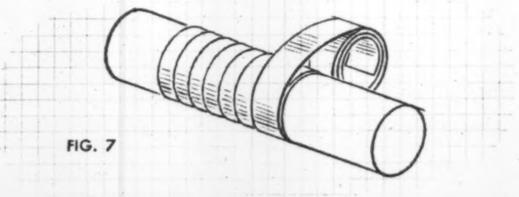


FIG. 7

EXTENSION SPRING

MOTOR

CLAMP

CLIP

HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

29 Spring Avenue, Lansdale, Pennsylvania

SPRINGS • STAMPINGS • QUALITY CONTROL EQUIPMENT

HS3955-2M-459D8

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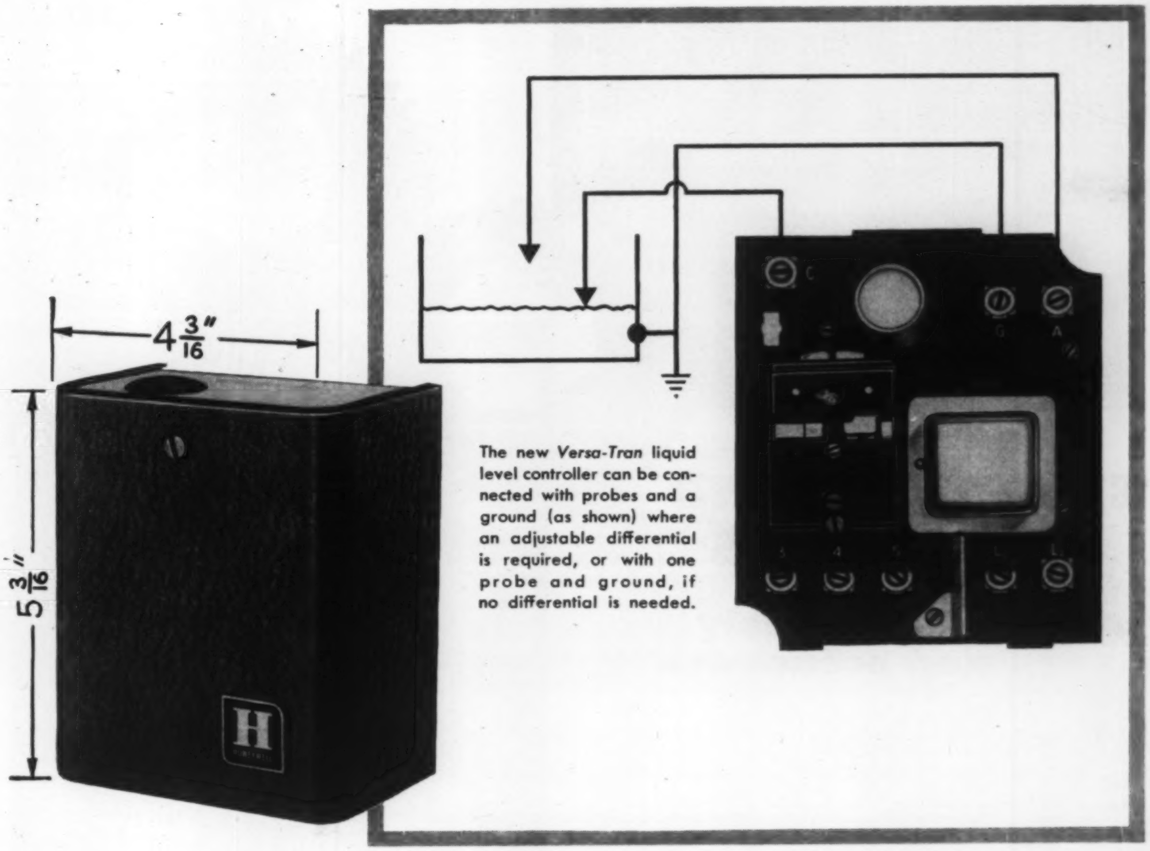


The new *Versa-Tran* liquid level controller can be connected with probes and a ground (as shown) where an adjustable differential is required, or with one probe and ground, if no differential is needed.

New low cost, high precision VERSA-TRAN® simplifies liquid level control

Here's a simple, easily-installed electronic controller that accurately controls the level of any electrically conductive liquid with a measured impedance not exceeding 25,000 ohms, measured at the probe-type sensing element. Its features include:

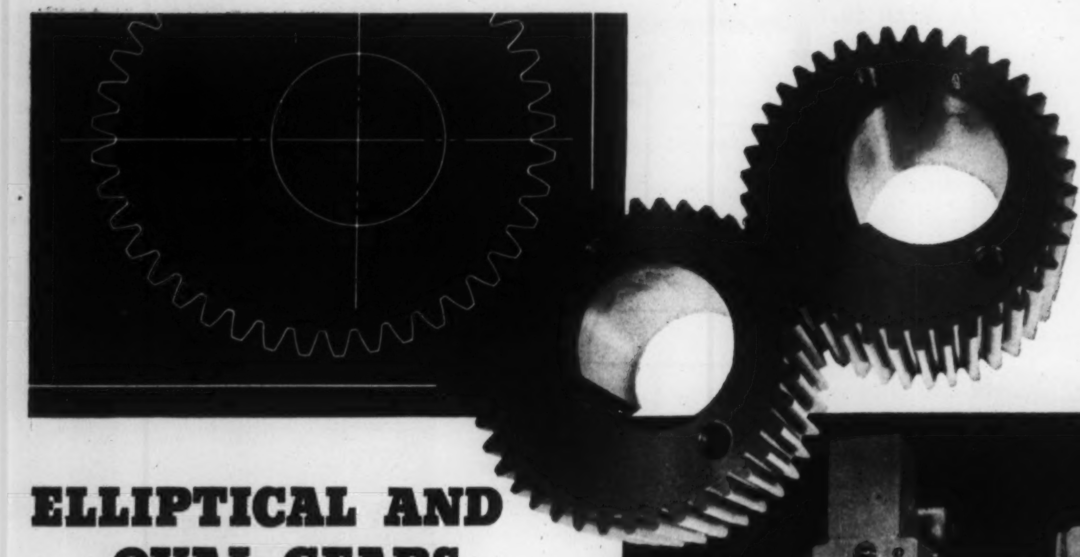
- Unique, fully transistorized design which eliminates need for field adjustment and calibration.
- Choice of fixed or adjustable differential by use of either one or two probes.
- Wiring between relay and probes can be ordinary 18 gauge, 2-conductor cable.
- No floats or standpipes necessary.
- Relay can be flush mounted, surface mounted or mounted in most electrical enclosures.
- All components zinc-chromate treated for corrosion resistance.

Your nearby Honeywell field engineer can help you profitably apply the new *Versa-Tran* liquid level controller. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Control

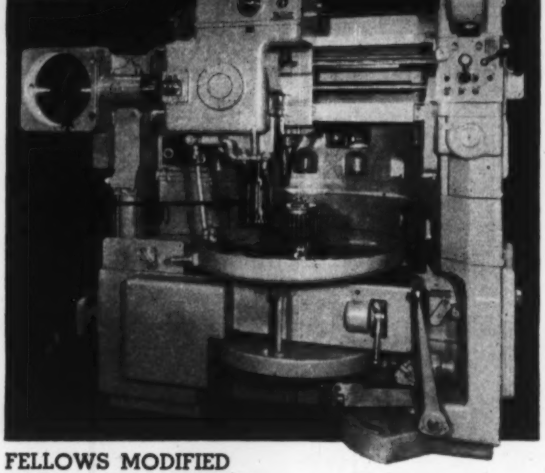


ELLIPTICAL AND OVAL GEARS

produced accurately and economically

Until now, owing to production difficulties, the design advantages of oval or elliptical gears have rarely been realized. Now Fellows has developed a unique method of generating these gears rapidly and economically. This new method minimizes the difficulty of wide variations in backlash experienced with such gears cut by previous methods. Full or modified involute teeth are produced to a higher degree of accuracy than was ever possible before on gears of this type. Production in any quantity is as simple as in cutting conventional cylindrical gears, once the setup has been made.

Fellows Modified 36-Type Gear Shaper generates elliptical or oval gears by continuously varying the center distance between cutter and gear during the cutting operation. A contour cam (A) and follower move the saddle the required amount in timed relationship with the rotation of the eccentric cutter-spindle adapter (B) to produce the gear pitch line contour.



FELLOWS MODIFIED
36-TYPE GEAR SHAPER

In addition to *oval and elliptical gears* up to a maximum pitch diameter of 18", the Modified Fellows 36-Type Gear Shaper can produce a remarkable variety of *irregular contours* at high production rates. Two cams, a cutter-spindle adapter and a cutter are required for each gear or other shape specification. For further information, get in touch with any Fellows office.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE
PRECISION
LINE

Fellows *Gear Production Equipment*

Do you need pressurized air for jobs like these?

- Oil or Gas Furnace Blowing
- Cupola Blowing
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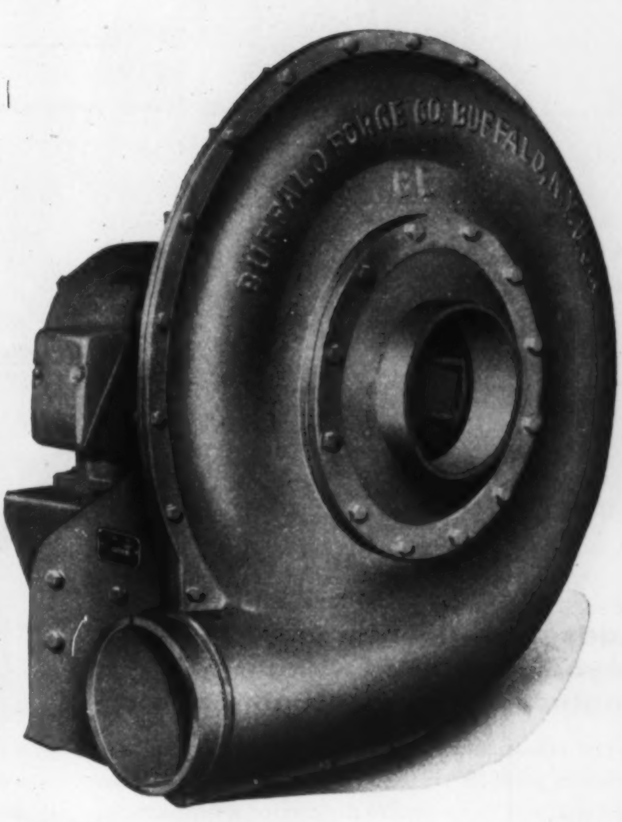
- Exhausting from Grinding Wheels

• • then this is what you need!



"BUFFALO" TYPE "E"
BLOWERS AND EXHAUSTERS

Wherever you need constant air pressures up to 5500 cfm, these dependable "Buffalo" Blowers will do the job most efficiently and economically. Compact, ruggedly-built, direct-connected "Buffalo" Type "E" Blowers and Exhausters are available in eight sizes. Pressures up to 2 lbs. mean you can choose the units exactly suited to your needs.

Various special features are available, including flanged inlet, flanged outlet, stuffing box around the shaft for gas-tightness. For corrosive fume handling, housings can be coated with Bisonite or Heresite. Housings may also be cast of special metals. Stainless steel, Everdur, brass or aluminum wheels are available. Used in multiple, these units are more flexible and economical than a single large blower.

For full information on "Buffalo" Type "E" Blowers and Exhausters, contact your "Buffalo" engineering representative—or write us for Bulletin FMB-935. Other units suitable for higher pressures are the type RE and type CB blowers.

"Buffalo"

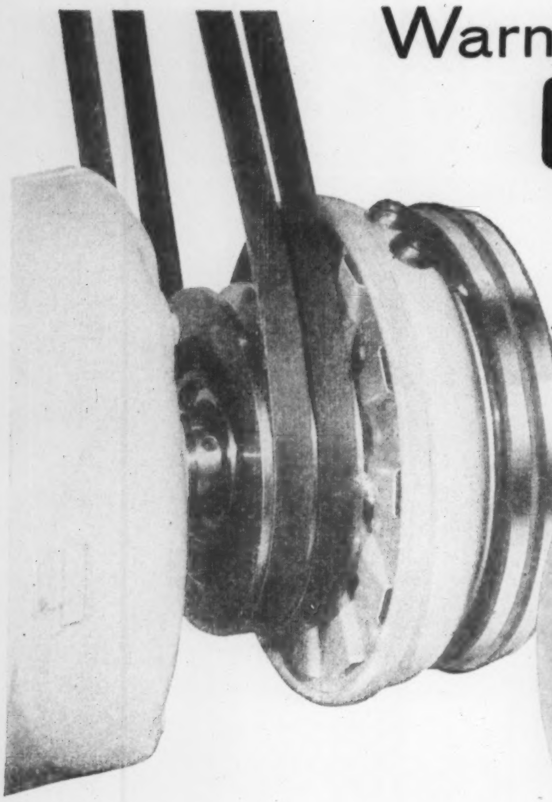
BUFFALO FORGE COMPANY
Buffalo, N. Y.
Buffalo Pumps Division, Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

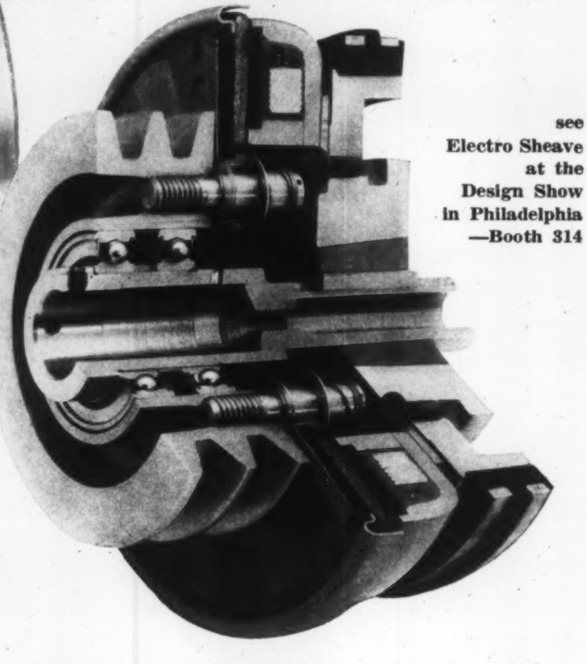
VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOW'NG

Circle 495 on Page 19

Warner's new Electro-clutch-and-pulley

mounts directly to any





**see
Electro Sheave
at the
Design Show
in Philadelphia
—Booth 314**

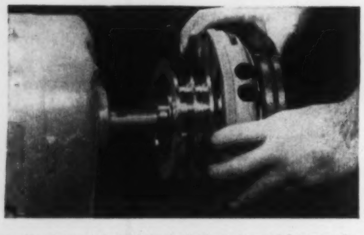
Adds powerful new sales features to your machines without engineering or machining costs

If you manufacture special machinery or standard machines in small-lot sizes, the Electro-Sheave is an easy, *economical* way to modernize the control system without adding appreciably to cost.

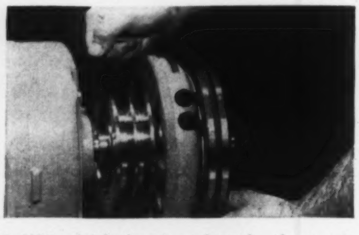
Manufacturers *and users* of machine tools, textile machinery, automatic packaging equipment, and printing machinery—just about every type of machine you can name—have proved that power drives controlled by Warner electric brakes and clutches increase productivity, reduce maintenance, and simplify operation.

You can mount this packaged clutch-pulley combination direct to any standard NEMA motor shaft, just as if it were custom-engineered to your equipment. Warner has solved all your engineering, machining, and alignment problems. There are no parts to design or make—in fact, for horizontal mounting you don't even drill a hole.

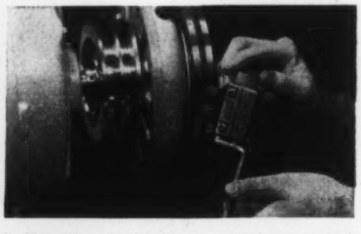
Electro-Sheave has its own shaft extension which carries the clutch, bearings, and sheave. In minutes, it can be mounted to the motor shaft, wired to the pushbutton panel or automatic controller, and belted to your machine.



1—Packaged clutch-and-sheave assembly mounts easily to any standard NEMA motor shaft. No machining or alignment necessary.



2—With clutch-sheave package in place, setscrews secure the built-in shaft extension, which transmits motor rotation to the clutch magnet.



3—Mount brushholder to any stationary member, such as motor frame, and wire it to the control panel—three easy steps modernize your drive.

Sheave

package

standard NEMA motor shaft

NEW electric
motion control
FACTS
for IDEA MEN!

Modernizes machine operation and control wherever motors drive intermittently

• Any motor-driven machine which stops and starts intermittently can be modernized and made more automatic by this new Warner Electro-Sheave clutch-pulley package.

As you examine its operating principle, you will see challenging new control possibilities which set the Electro-Sheave apart from other devices for cycling a machine drive. The primary reason, of course—*direct electrical operation*.

Torque produced electrically

When there is no current to the clutch, the sheave runs freely on antifriction bearings. But, as soon as the clutch is energized by 90 volt d-c, motor torque is transmitted to the sheave through electromagnetic engagement of the disc-shaped armature and magnet. A full magnetic couple can be produced in milliseconds. This leads to the second important difference—"packaged actuation."

The clutch operating current can be controlled adroitly by almost any automatic sensing device. Actuation is direct. Thus, it is easy to interlock Electro-Sheaves to synchronize machinery . . . make complex operations more precise or foolproof . . . control operations automatically . . . or position pushbutton controls where you want them.

The Electro-Sheave has no mating teeth as with most solid connections, yet provides a powerful, no-slip drive under normal operating loads. Torque capacity remains constant throughout its entire wear life. Build-up speed is adjustable in stepless increments. You simply dial a potentiometer in the control panel to speed it up or slow it down. This gives you exactly the right acceleration for any torque, speed, or timing problem. It's a feature that cannot be duplicated in a practical manner with any other starting device.

Provides versatile no-load starts

As an automatic, no-load clutch, the Electro-Sheave offers many advantages. First, it engages and releases *at any speed*. For inching and jogging, several starts are possible in less than one revolution of the clutch without the usual wear on motors, controls, and machinery. You can release instantly and brake the load without plugging the motor. It's the fastest way to cycle a machine drive because the high inertia of the motor rotor helps start the load but does not affect braking speed. Your operating power requirements are reduced, and in many cases, you can switch to smaller motors and starters.

Think of the control versatility it opens up—and at a "packaged price" because the power panel, actuating pushbuttons, wiring, and Electro-Sheave all can be installed without costly machining or engineering time. It's a simple assembly job.

Electro-Sheaves are now in production and available for off-the-shelf delivery to you from all Warner power transmission distributors. Five sizes, from 1 to 25 hp. Send coupon below for complete facts.

No other motor-mounted clutch or coupling performs all these functions

Engages and disengages at any speed • Protects against overloads Permits stepless torque modulation • Eliminates slippage at normal loads • Dissipates heat rapidly • Adjusts automatically for wear • Adapts to all modes of control • Speeds engagement and release • Accelerates smoothly • Simplifies servicing and sheave changing • Saves clutch, starter, and motor costs • Reduces power consumption • Eliminates special sheaves • Reduces assembly costs • Eliminates engineering time • Requires no shaft extension Improves inching and jogging.

WARNER

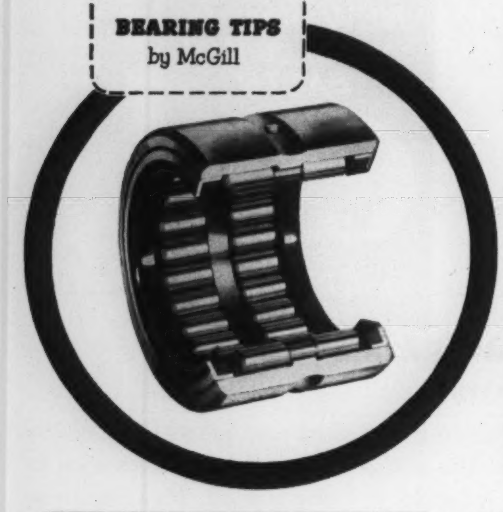
Warner Electric Brake & Clutch Co.
Dept. MD, Beloit, Wisconsin

Gentlemen: Please send complete data on Electro-Sheaves.

Name____________________Title________
Company____________________________
Address____________________________
City________________Zone____State______

Circle 496 on Page 19

BEARING TIPS
by McGill



McGILL sealed GUIDEROL® bearings preserve high capacity performance of needle bearing applications

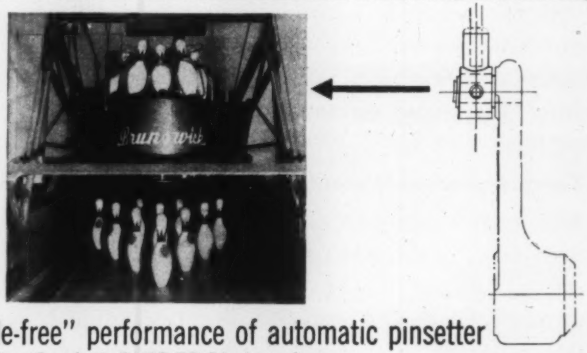
Lip type contact seals built into GUIDEROL bearings insure longer life for their high capacity performance in limited radial space. It's simpler and less costly to apply these sealed bearings than build in auxiliary seals that increase bearing width and housing requirements.

GUIDEROL bearings, including the sealed series, are precision built and combine the inherent high capacity of full complement roller bearings with the control of center guided rollers. This recommends the bearing for applications too heavily loaded for retainer type bearings, but where shaft deflection and misalignment prevents the use of ordinary full type roller bearings.

Seals keep contamination out and lubrication in. This assures trouble free performance where maintenance is costly or impractical.

Sealed GUIDEROL minimizes torque in ACF "Piggy-Back" trailer hitch

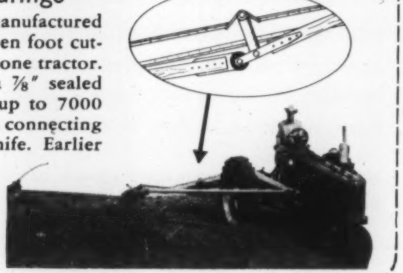
McGILL Sealed GUIDEROL bearings meet the requirements of a high capacity needle bearing for small radial space, having adequate seals to prevent entry of foreign materials and loss of lubricant in this exposed application. The bearings, in the elevating arms, minimize the amount of torque required to elevate the trailer hitch and jack the trailer off the car floor. The hitch, manufactured by American Car and Foundry Division of ACF Industries Incorporated, is a tiedown and cushioning unit for semi-truck trailers on flat car (Piggy-back) use. Although speeds are low, loads are as high as 20,000 lbs. per bearing. Grease relubrication when desired is applied through the shaft to the inner race of the bearing.



"Trouble-free" performance of automatic pinsetter called for Sealed GUIDEROL bearings

Prelubricated and Sealed GUIDEROL bearings are used in two applications in BRUNSWICK AUTOMATIC PINSETTERS; on the Rake Crank Lever Assembly and on the Jogger Arm Assembly. The photo shows the location of the sealed GUIDEROL Rake Crank Lever application in the "mechanical brain" of the machine. The sealed GUIDEROL bearings help keep the "brain" highly efficient, with a minimum of maintenance. In the Rake Crank they are not relubricated and operate indefinitely on retained lubricant. Effective seals keep out dirt and foreign matter.

New mower design takes high cutting loads on Sealed GUIDEROL bearings



These unusual field mowers manufactured by Kosch Mfg. Co. use two seven foot cutting bars for a 14 foot cut with one tractor. The second bar depends on a 7/8" sealed GUIDEROL bearing to carry up to 7000 pound loads produced in the connecting drive for the reciprocating knife. Earlier sleeve and lower quality needle bearings were discarded for sealed GUIDEROL bearings that have prevented costly field breakdowns.

engineered electrical products

McGILL®

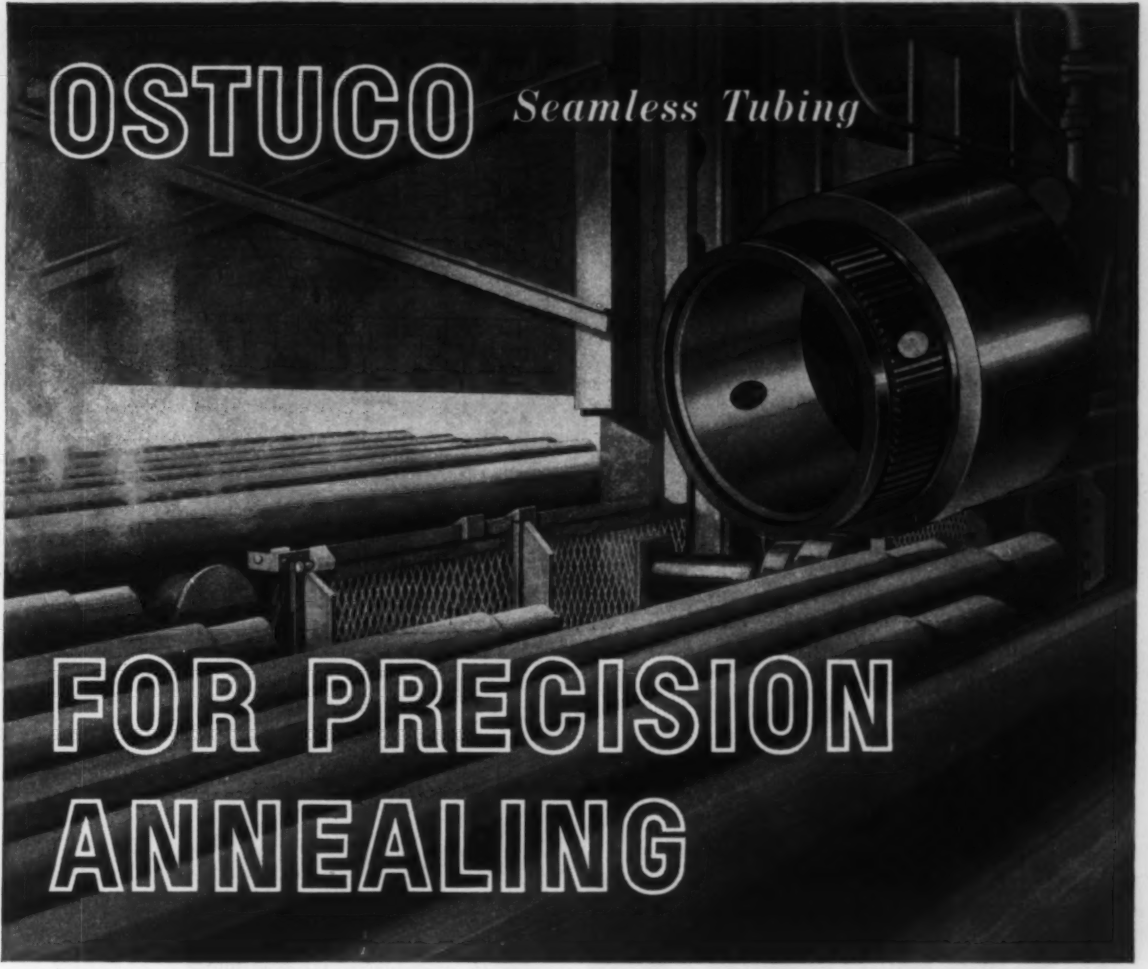
precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

Automatic Transmission Manufacturer Specifies



Annealing furnace at the Shelby mill. Ostuco tubing can be bright or soft annealed, stress relieved, normalized or heat treated.

“As a leading producer of quality transmission components, we can't leave anything to chance. Our design requirements, materials specifications and manufacturing processes are under the most stringent quality control standards. And we demand as much of our vendors.

"One sure way we have found to eliminate the unpredictable is to specify Ostuco Seamless Tubing. We know from experience we can rely on the precision annealing and unvarying quality of Ostuco tubing that slashes reject rates, helps us produce parts in quantity for profit . . . ”

If you want to eliminate the unpredictable in your own plant, then it's time you called your local Ohio Seamless representative. He's listed in the Yellow Pages. Or contact the plant at *Shelby, Ohio —Birthplace of the Seamless Steel Tube Industry in America.*

AA-9604

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OSTUCO TUBING

OHIO SEAMLESS TUBE DIVISION

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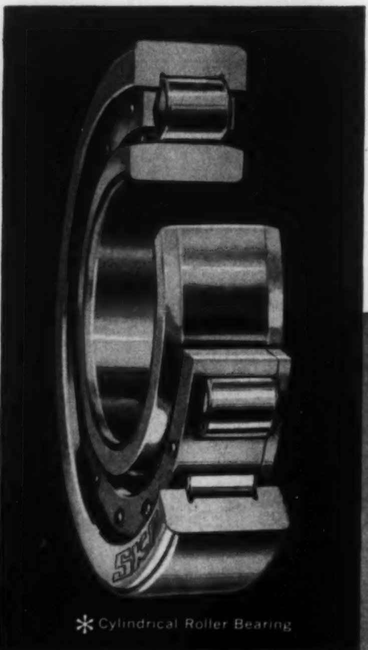
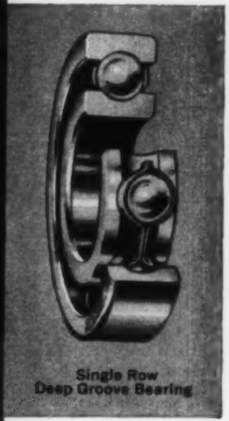
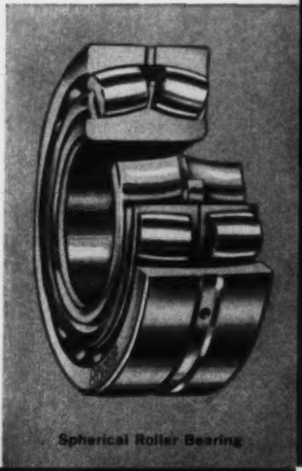
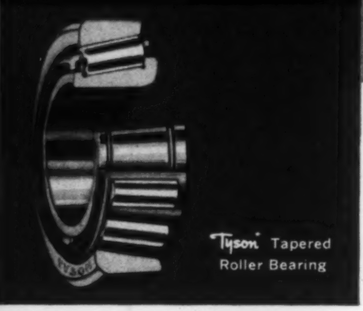
Circle 498 on Page 19

What's "special" about these standard SKF bearings?


* Cylindrical Roller Bearing


Single Row Deep Groove Bearing


Spherical Roller Bearing


Tyson Tapered Roller Bearing

Spherical Roller Thrust Bearing

Angular Contact Bearing

They all have exclusive features. Where else, for example, can you get the 33⅓% higher capacity available in standard SKF spherical roller bearings?

*Or, take the cylindrical roller bearing. This type provides high radial capacity and minimum shaft friction. Controlled shaft end float within the bearing is a natural advantage of this design.

Yet this is SKF's standard cylindrical roller bearing, promptly available in 154 sizes ranging from just under 1" to 6" (bore). In the double row it's 1" to 9.5".

Why not get the complete facts on these "special" but standard (and economical) bearings? For details, call any of the 25 SKF sales offices today. 5923

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DESIGN ENGINEERING SHOW
MAY 25-26
SKF BOOTH #618**

Spherical, Cylindrical, Ball, and Tyson Tapered Roller Bearings

EVERY TYPE—EVERY USE
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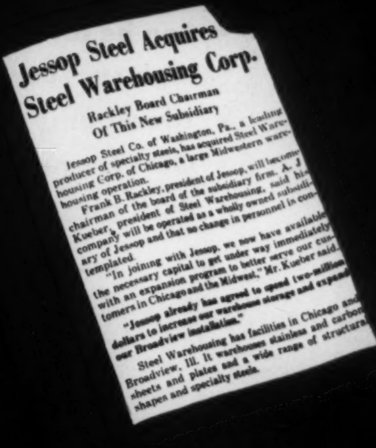


Jessop Steel Acquires Steel Warehousing Corp.

Rackley Board Chairman Of This New Subsidiary

Jessop Steel Co. of Washington, Pa., a leading producer of specialty steels, has acquired Steel Warehousing Corp. of Chicago, a large Midwestern warehousing operation.

Frank B. Rackley, president of Jessop, will becom chairman of the board of the subsidiary firm. A. J Kueber, president of Steel Warehousing, said hi company will be operated as a wholly owned subsidiary of Jessop and that no change in personnel is contemplated.

"In joining with Jessop, we now have availabl the necessary capital to get under way immediately with an expansion program to better serve our customers in Chicago and the Midwest," Mr. Kueber said.

"Jessop already has agreed to spend two-millio dollars to increase our warehouse storage and expand our Broadview installation."

Steel Warehousing has facilities in Chicago and Broadview, Ill. It warehouses stainless and carbon sheets and plates and a wide range of structura shapes and specialty steels.

Jessop buys Steel Warehousing Corporation ... another reason for your confidence!

When you specify Jessop specialty steels, you've got good reasons for that decision. For example . . .

With Jessop, you're dealing with success. Although it's only two years since the acquisition of Green River Steel, Jessop now adds Steel Warehousing of Chicago. Already a two million dollar expansion of warehousing facilities is underway.

This fast growth didn't just happen. It results from the Jessop policy of producing the highest quality specialty steels *and keeping delivery promises!*

Yes, you have good reasons to be confident when you specify Jessop.

VMA 6721

JESSOP
STEEL COMPANY
Washington, Pennsylvania

Subsidiary Companies:

Green River Steel Corporation, Owensboro, Kentucky
Jessop Steel International Corporation, New York City
Jessop Steel of Canada, Ltd., Wallaceburg, Ontario
Steel Warehousing Corporation, Chicago and Broadview, Ill.

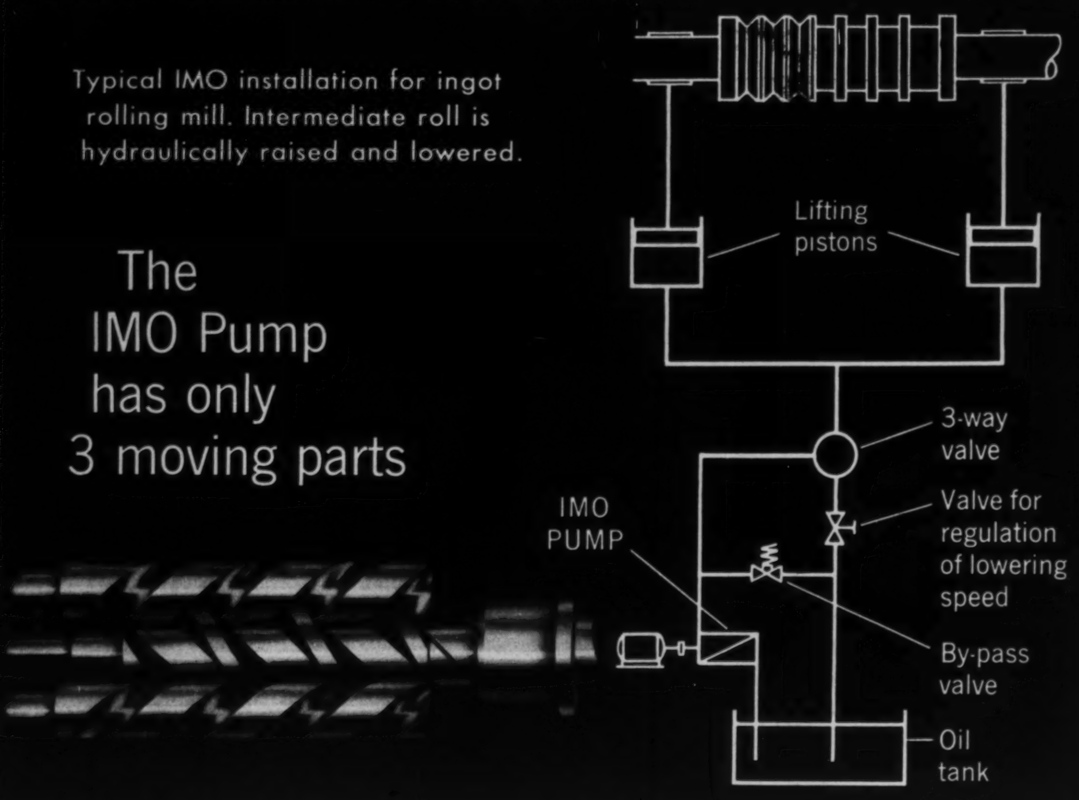
Stainless, alloy, tool, cast-to-shape, and forging steels, precision ground flat stock, and other specialty steels

Circle 500 on Page 19

DE LAVAL IMO PUMPS for Power Hydraulics

If you require a hydraulic pump for actuating any kind of equipment—lifting, tipping, loading, bending, pressing, etc. —consider the IMO. Here are its characteristics:

- **Smooth power flow without pulsation**
- **Can be direct-driven at high speeds without reduction gears**
- **Thoroughly dependable and proved**
- **QUIET, smooth rolling action**
- **Easily installed**


Lifting pistons
3-way valve
Valve for regulation of lowering speed
IMO PUMP
By-pass valve
Oil tank

Typical IMO installation for ingot rolling mill. Intermediate roll is hydraulically raised and lowered.

The IMO Pump has only 3 moving parts

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Circle 501 on Page 19

Norgren Air Line Filters

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Pipe scale, pipe dope, condensate, emulsified and deteriorated compressor oil — all damaging to connected air equipment — are inherently present in all compressed air systems. Provide for the efficient removal of these contaminants and assure top performance from air actuated devices by specifying a Norgren Air Line Filter in your design.

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- **Wide Operating Pressure Range**—Top efficiency at pressures as low as 5 psi—as high as 250 psi for metal bowl type.
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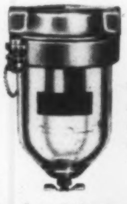
- **Abrasive Solids and Corrosive Liquids**—are removed from air lines, reducing equipment wear, repair and replacement costs.



Norgren Manual Drain Air Line Filter (Norgren Automatic-Drain Air Line Filter is illustrated above.)

For complete information, call your nearby Norgren Representative listed in your telephone directory—or WRITE FOR DESCRIPTIVE LITERATURE.

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Circle 502 on Page 19

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

One in a series of technical reports by Bower

BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

FIG. 1

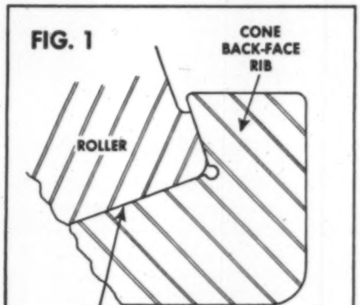
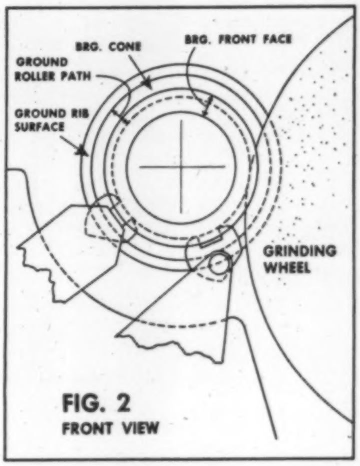


FIG. 2
FRONT VIEW

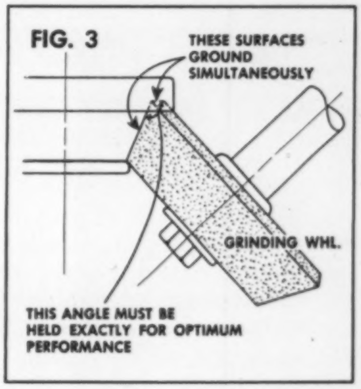


In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and side views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

FIG. 3



* * * *

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

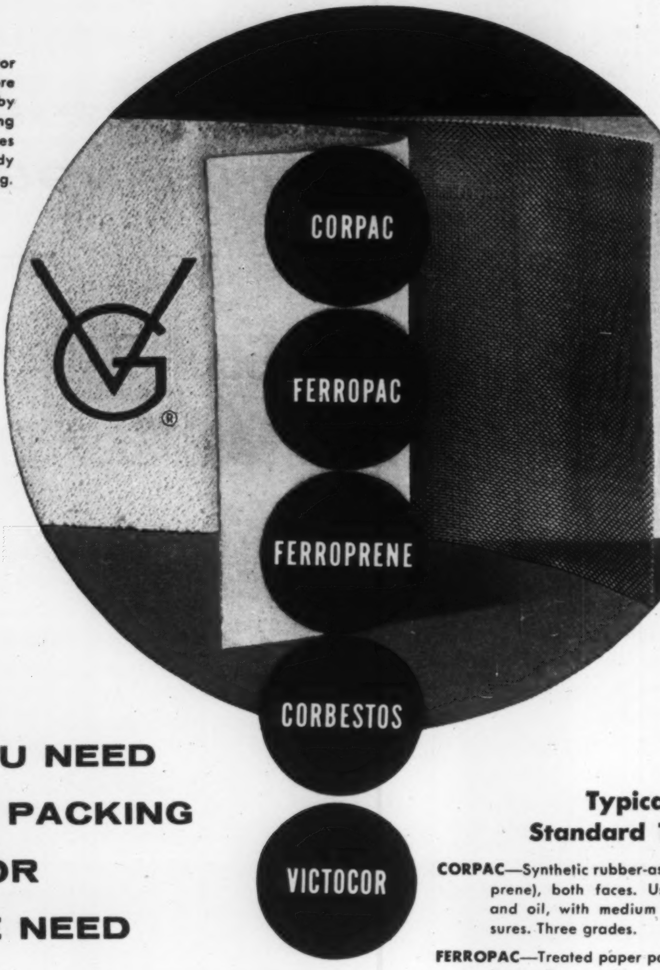
BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

Circle 503 on Page 19

LOCKED-FOR-LIFE Victor construction. Packing and core are permanently bonded by means of formed tang projections on both faces of core, clinched into body of packing.



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From the widest range of highly engineered, SAE-ASTM rated packings, Victor literally can "tailor-make" steel core gaskets to your most precise specifications. Where needed, Victor successfully modifies the characteristics of standard types with virtually unlimited combinations and structures.

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CORPAC—Synthetic rubber-asbestos sheet (Asbestoprene), both faces. Used under high heat and oil, with medium to high flange pressures. Three grades.

FERROPAC—Treated paper packing (Victorite), both faces. For service against gasoline, oil, grease, water, under medium flange pressures. Holds up under frequent dismantling.

FERROPRENE—Compressed asbestos sheet packing (Victopac) one side, compounded synthetic rubber (Victoprene) on other. Useful under high heat and oil; low to medium flange pressures.

CORBESTOS—General-purpose, beater-treated asbestos sheet packing for use on oil, gasoline, water, steam, antifreeze. Adaptable to all temperature and bolting pressure needs. Six standard structures including double-sided, single-sided, steel-faced and laminated.

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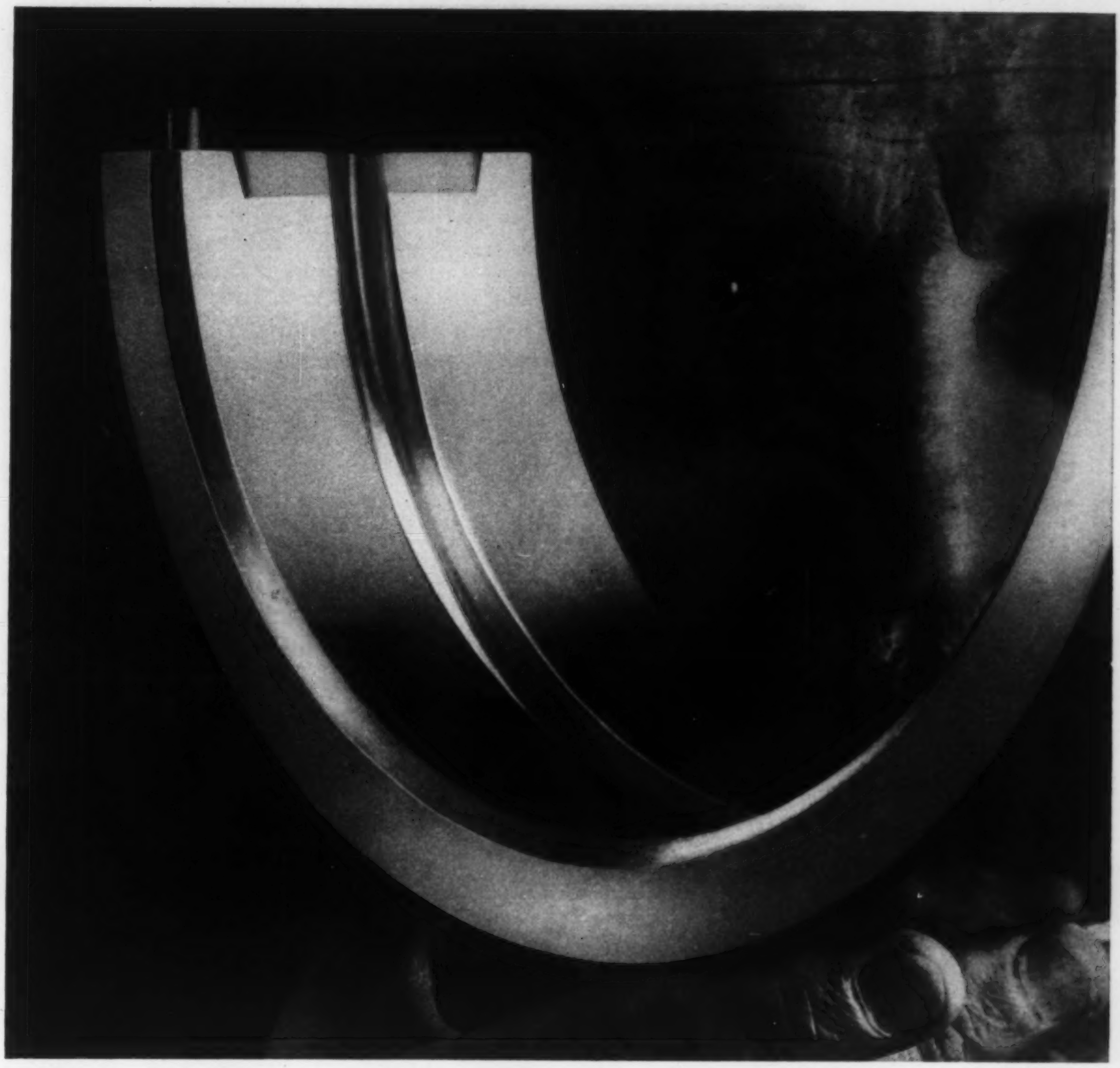

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Solid aluminum bearings, being monometallic in construction, protect costly shafts. Rugged service in a host of applications from railroads to rolling mills has proven their unmatched load-carrying ability. This means that with the same size bearing you can design for higher engine output. Or, if engine output is to remain the same, you can use a smaller bearing of aluminum and gain design advantages, such as: shorter and stiffer crankshafts, smaller and more compact engines and increased hp per cubic inch. In addition, aluminum bearings . . . RUN COOLEST of *all* bearing metals, because aluminum is the best heat conductor. Actual tests show heat reductions up to 20°F.

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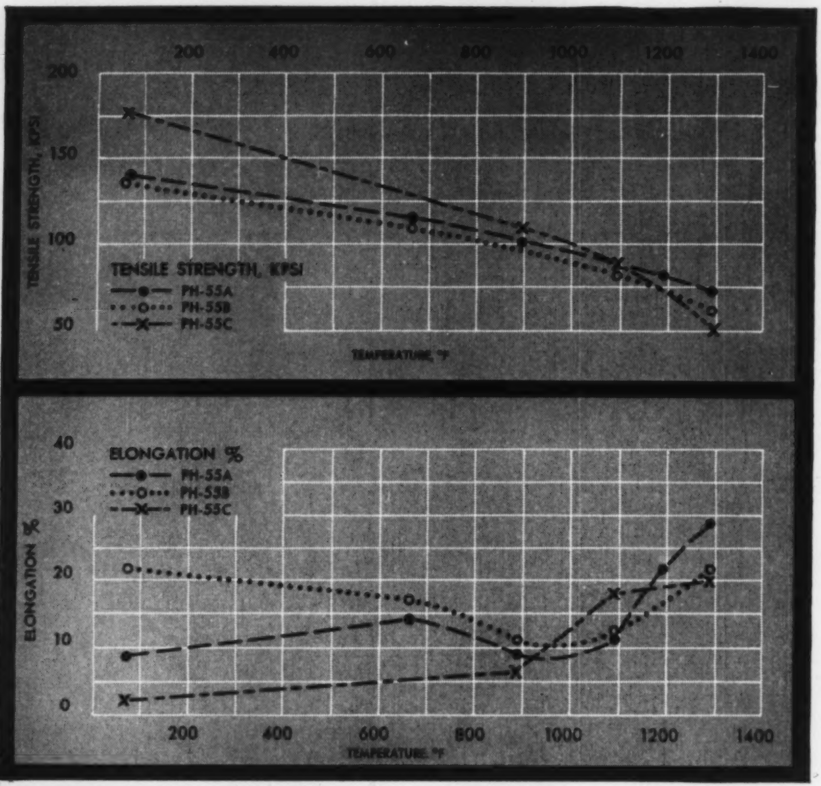

Balanced physical properties—Alloy "A" has good hardness and strength, even at elevated temperatures, plus a moderate amount of ductility and toughness. "B," though less hard, exhibits improved ductility and toughness at practically the same strength level. "C" provides optimum combination of hardness and strength at room temperatures.

Precipitation-hardenable stainless steel alloys by Cooper Alloy that combine corrosion resistance, high hardness, machinability and strength even at high temperatures.

New stainless steel alloys by Cooper Alloy

Where Can You Use Them? Cooper Alloy Corp., whose name for the past 36 years has been associated with outstanding developments in casting of stainless steel, now brings American industry another unusual "first": a series of 18-8 stainless alloys which combine corrosion resistance, high hardness, high strength and machinability. The new alloys maintain these properties even at temperatures up to 1400°F., resisting pitting corrosion and the detrimental erosion effects of velocity and suspended abrasives which accentuate corrosion damage.

The alloys in this new series are:

PH-55A: A high-strength, high-hardness alloy designed for corrosion-erosion and corrosion-abrasion conditions. Outstanding pitting resistance.

PH-55B: A high-strength alloy of greater ductility and lower hardness than "A," for corrosion resistance of parts subjected to a combination of stress and shock.

PH-55C: With greater corrosion resistance, hardness, and strength than "A," but less ductility and shock resistance.

All PH-55 Alloys have higher strengths in the 1200-1400°F. range than do most other corrosion-resistant precipitation-hardening alloys, and they maintain their hardness even after prolonged exposure to these high temperatures. Alloy "A" is highly resistant to pitting corrosion; both "A" and "C" to high-velocity erosion-corrosion such as is common in pumps handling corrosive abrasives. All three are in general superior to 316 alloys in all corrosive applications except hot conc. HNO_3. Patents have been applied for or granted on the PH series of alloys.

Alloys "A," "B," and "C" are all easily machined when in the annealed condition. Welding is routine, and heat treatment easy and relatively uncritical.

Where can YOU use these alloys? They should be very useful anywhere that velocity, abrasion, wear, and high temperature are present under highly corrosive conditions.

For further information, write to Cooper Alloy Corp., Hillside, N.J.

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FEATURES of Bendix-Westinghouse piston-type air and hydraulic cylinders:

Perfect alignment • High tensile, heavily chromed rod • Metal rod scraper • Self-adjusting packings • 360° rotation of ports • Spot-faced mounting holes • Full cushioning without length increase • Heavy wall precision honed tubing • Cartridge type rod bearing • "O" ring seal between head and cylinder wall • Built to J. I. C. standards

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INDUSTRIAL PRODUCTS

Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio

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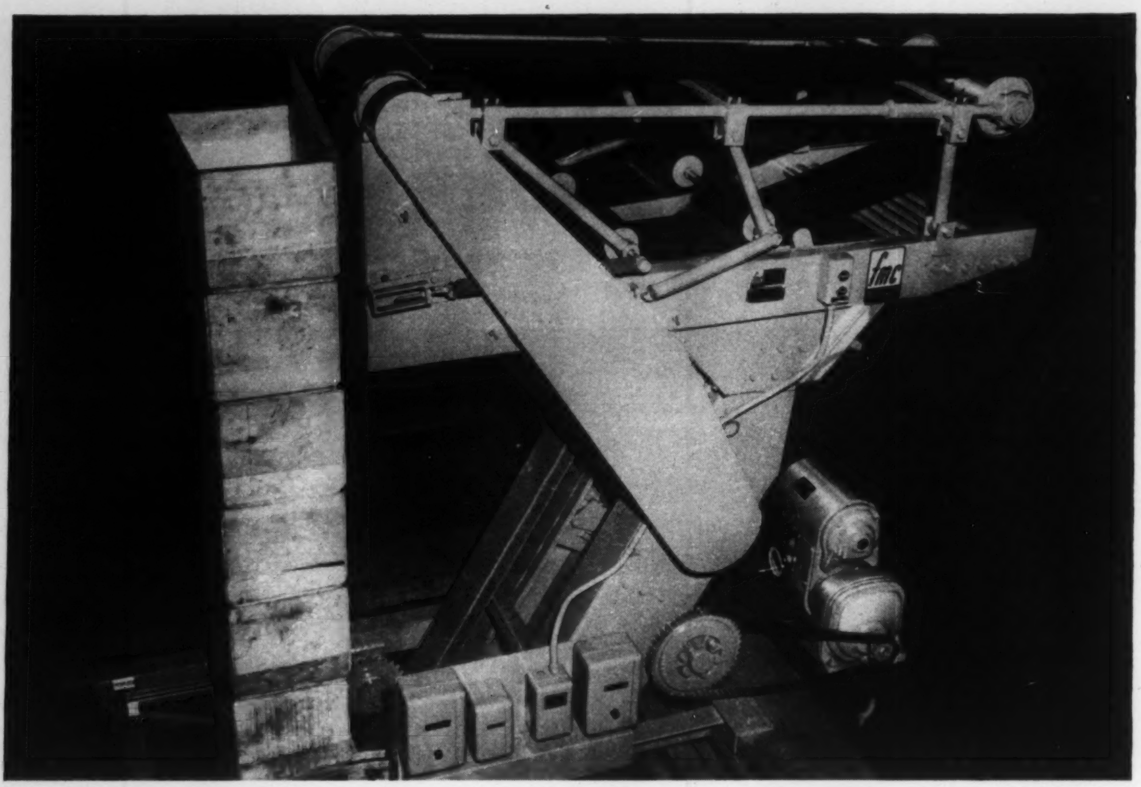


"BECAUSE RELIABLE SPEED CONTROL IS VITAL..."

FOOD MACHINERY & CHEMICAL CORPORATION SPECIFIES STERLING SPEED-TROL VARIABLE SPEED DRIVES!

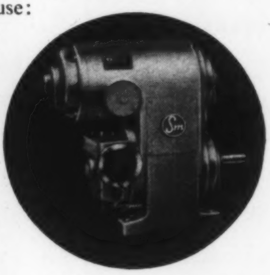
Designed to handle a varying load of from 8 to 24 boxes of fruit per minute, Food Machinery's Model 384000 Series Automatic Stack Elevating Box Dumper is powered by a Sterling Speed-Trol Variable Speed Drive for accurate control of operation throughout the range of packing requirements.

"We have specified Sterling Speed-Trols because reliable speed control is vital in equipment of this type," says E. A. Verrinder, Chief Engineer of Food Machinery's Packing Equipment Division. "Our machine is designed to adjust the flow of fruit to accommodate varying quantities of incoming fruit, and to match the flow of fruit to the number of workers on the processing line. Through the Speed-Trol's infinite control of speed, speed can be quickly, easily and accurately changed as required.

"Our long and successful experience with Sterling Speed-Trols has proven to us... and to our customers... that these variable speed drives provide the dependability and efficiency required for our packing equipment."

Only STERLING SPEED-TROL provides these features for reliable speed control:

- Positive coordinated control of both pulleys—"no springs."
- Maximum pulley life because:
  (1) variable pulleys ride on hardened, chrome-plated, precision-ground, keyed shafts;
  (2) large grease reservoirs provide a film of protecting lubricant.
- Longer belt life... no additional load from spring.
- Greater safety... No injuries from spring flying loose during maintenance.



For additional information about the unique advantages of Sterling Speed-Trol, ask for your free copy of Bulletin 195. Write to:

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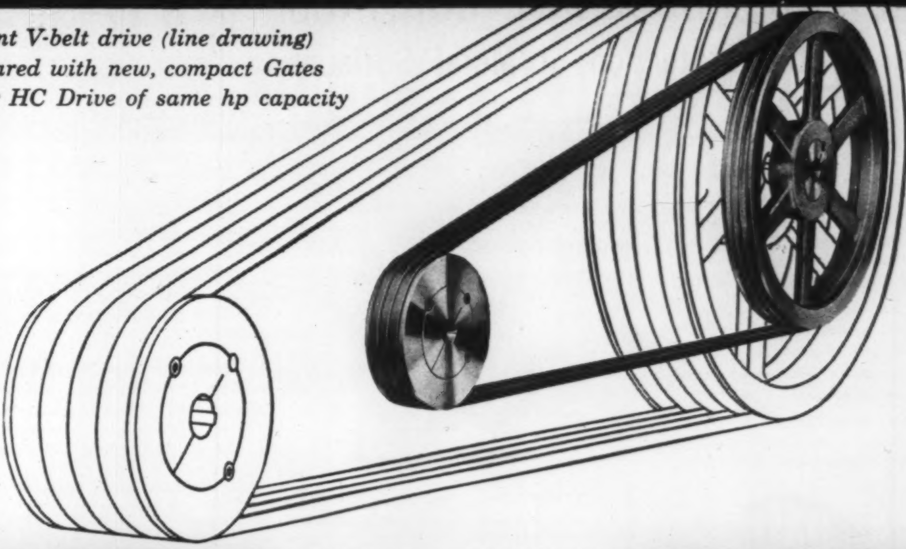
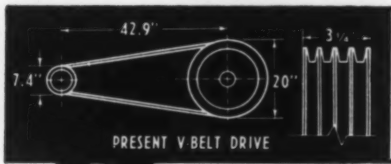
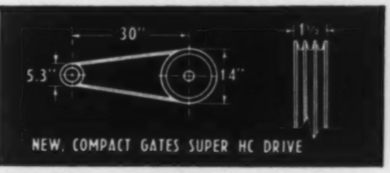
Present V-belt drive (line drawing) compared with new, compact Gates Super HC Drive of same hp capacity





COMPARE: Left, typical drive with present V-belts. Right—drive of same hp capacity with Gates new Super HC V-Belts . . . uses fewer belts, smaller sheaves and shorter center distance.



Exclusive cross-section design: The precisely engineered arched top, concave sidewalls (U. S. Pat. 1813698) and special tensile construction insure full pulling power and longer belt life.

Reduces drive cost as much as 20%

A major advance in the field of power transmission is the fully proved Gates Super HC V-Belt. This high capacity belt makes possible the lowest-cost lightest-weight, most compact multiple V-belt drive that can be put on any machine.

The cost of a new Gates Super HC V-Belt drive is as much as 20% under the cost of present V-belt drives of the same hp capacity.

For an informative new handbook, *"The Modern Way to Design Multiple V-Belt Drives,"* call your nearby Gates Distributor or Gates Office listed under Belts or Belting in the Yellow Pages of your phone book.

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Gates Super HC V-Belt Drives

AMCHEM Information Bulletin

A REVIEW OF PHOSPHATE COATINGS

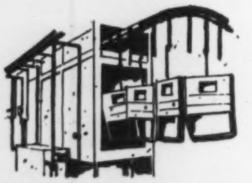
Specified for the Protection of Metal Surfaces

By HUGH GEHMAN, Assistant Manager, Product Development Dept., AMCHEM PRODUCTS, INC.

Phosphate coatings are protective inorganic finishes that actually change the chemical nature of metal surfaces. The metal reacts with the applied phosphate solution to form a nonmetallic, crystalline coating which serves to:

- **Improve paint adhesion**
- **Provide protection against corrosion**
- **Increase lubricity of friction surfaces**
- **Facilitate mechanical deformation of metals**
- **Decorate—in many instances**

Satisfactory protection of steel, zinc and aluminum surfaces against corrosion, paint peeling and blistering, and hard wear requires precision methods of chemical conversion coating.



Typical automotive spray installation.

Types of Conversion Coatings

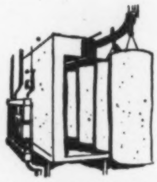
There are seven classes of chemical conversion coatings commonly specified and used throughout industry today. They are as follows:

Zinc-iron phosphate (Amchem Granodine). This is the heaviest type of coating (gray in color) used for prepaint treatments on steel, iron and zinc surfaces. The process requires five or six operations: cleaning; rinsing; rust removal, if necessary; coating; rinsing; and a second rinse. Coating weight ranges from 100 to 600 mg per sq. ft.

Medium or large volume production of automobile bodies, appliances, projectiles and cabinets can be handled effectively.

The coating solution improves paint adhesion by forming a crystalline deposit over the metal surface. This deposit is rough, as revealed microscopically, and so offers an ideal gripping surface for paint particles.

Manganese-iron phosphate (Amchem Thermoil-Granodine). This is a heavy black coating used on friction surfaces to prevent galling, scoring and seizing of parts. Typical metal parts treated are pistons, piston rings, gears, cylinder liners, camshafts, tappets and various small arms components.



Typical appliance treatment line.

Iron phosphate (Amchem Duridine). This is a comparatively new process that places a light coating on surfaces for improved paint adhesion. Since cleaning and coating occur in the same bath, it has only three to five stages.

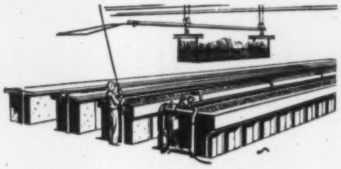
The iron phosphate treatment is a spray process suited for medium to large volume, large or small work. Precleaning is normally unnecessary, an economy factor in its favor.

Products protected by this process are steel or iron fabricated units, such as cabinets, washing machines and refrigerators. Weight of coating is 50 to 100 mg per sq. ft.

Zinc phosphate (Amchem Lithoform). This is a crystalline coating produced on galvanized iron and other zinc surfaces—also cadmium—for improving paint adhesion. The purpose of the coating is to provide a paint-gripping surface and to prevent the reaction between acidic components of the paint and the zinc metal, with the formation of soaps and loss of paint adhesion.

This coating is applied in weights of 75 to 500 mg per sq. ft. There are no limitations on volume or production or on size of products treated. Zinc phosphate coating is used on zinc alloy die castings, zinc or cadmium plated sheet or components, hot dip galvanized stock, and Galvanneal.

Amorphous phosphate (Amchem Alodine). This a protective coating for aluminum and aluminum alloys.

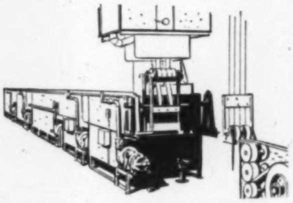


Typical aircraft dip installation.

It may be used in place of anodic deposition for improved paint adhesion and corrosion resistance.

This coating is practical for production in any volume. Coating weight is 100 to 600 mg per sq. ft. Products treated include aluminum awnings, doors and windows, aircraft and aircraft parts, missile parts, roofing and siding. Particularly good when aluminum is painted prior to forming.

Zinc-iron phosphate for oil absorption (Amchem Permadine). This is a relatively heavy coating adapted to the retention of rust-inhibiting drying or nondrying oils and waxes on ferrous metal surfaces. The coating is applied to a weight of 1000 to 4000 mg per sq. ft.



Typical continuous strip line installation.

The process is satisfactory for large or small work in any volume—nuts, bolts, hardware, guns, tools, etc.

Zinc-iron phosphate for metal forming (Amchem Granodraw). This is a specialized coating used in conjunction with a suitable lubricant to facilitate the cold mechanical deformation of steel. The coating acts as an anchor for the lubricant throughout drawing, extrusion, and cold forming operations.

It is a successful treatment for products such as blanks and shells for cold forming, heavy stampings, impact extruded shapes, drawn wire and tube.

For more complete information about any one or all of these chemical conversion coatings, contact an Amchem sales representative or write us at Ambler 18, Pa.

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Circle 510 on Page 19

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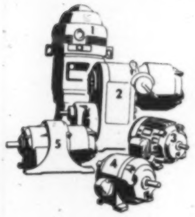

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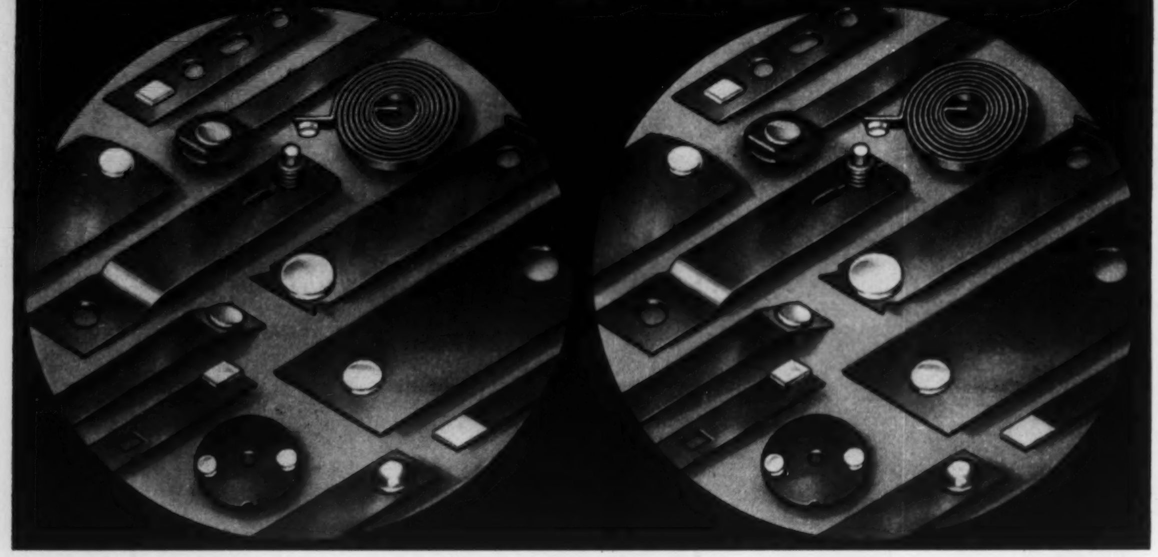

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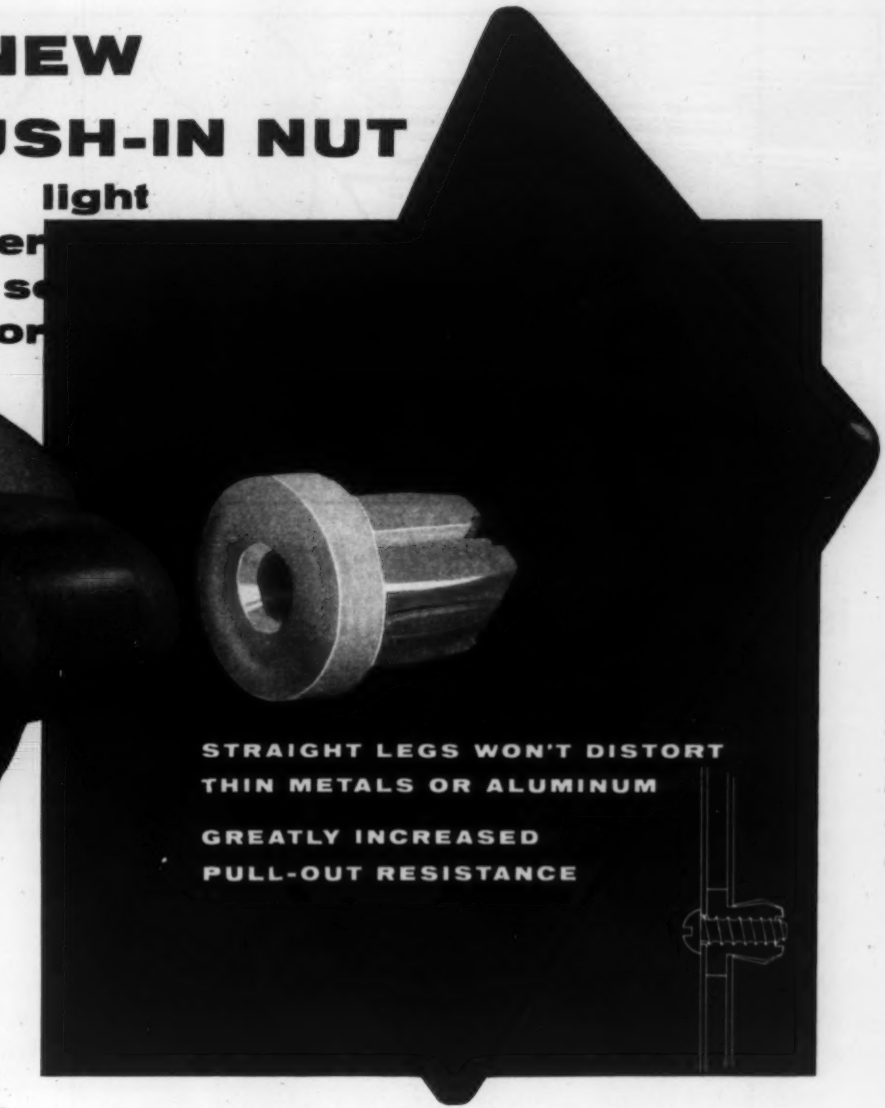
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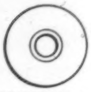
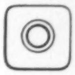
PATENT PENDING


ROUND HEAD


SQUARE HEAD

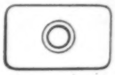

RECTANGULAR

TABLE OF DIMENSIONS

For use with #8 or #10 screws, finished hole size .290/.281, application thickness .030/.060. Other sizes available soon.

HEAD SIZE	HEAD HEIGHT
7/16" DIA.	.150
1/2" DIA.	.030
1/2" DIA.	.040
1/2" DIA.	.070
1/2" DIA.	.150
1/2" DIA.	.100
3/8" SQ.	.040
3/8" SQ.	.140
13/32" SQ.	.030
13/32" SQ.	.200
3/8" x 37/64"	.060

This new Dot Nylon Push-in Nut offers additional design and performance advantages over our currently available plastic snap-in nuts. These advantages are:

(1) Straight legs permit easy insertion in square, punched holes and do not distort the holes even in soft aluminum or thin-gauge steel. (2) Burrs do not impede the nut or prevent proper seating. (3) Tapered screw hole causes legs to spread when screw is inserted and results in greatly increased pull-out resistance (see drawing A).

Ordinary sheet metal screws cut clean, strong threads in the molded nylon and the nut is both re-usable and highly resistant to vibration.

Used as a nut or as a spacer, Dot's Nylon Push-in Nut has wide application in all products where sheet metals or plastics are employed. They can be supplied with a moisture resistant sealer and special nuts can be designed to your specifications if volume warrants. Currently available in eleven sizes. Full information on request.

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Division of United-Carr Fastener Corp., Cambridge 42, Mass.

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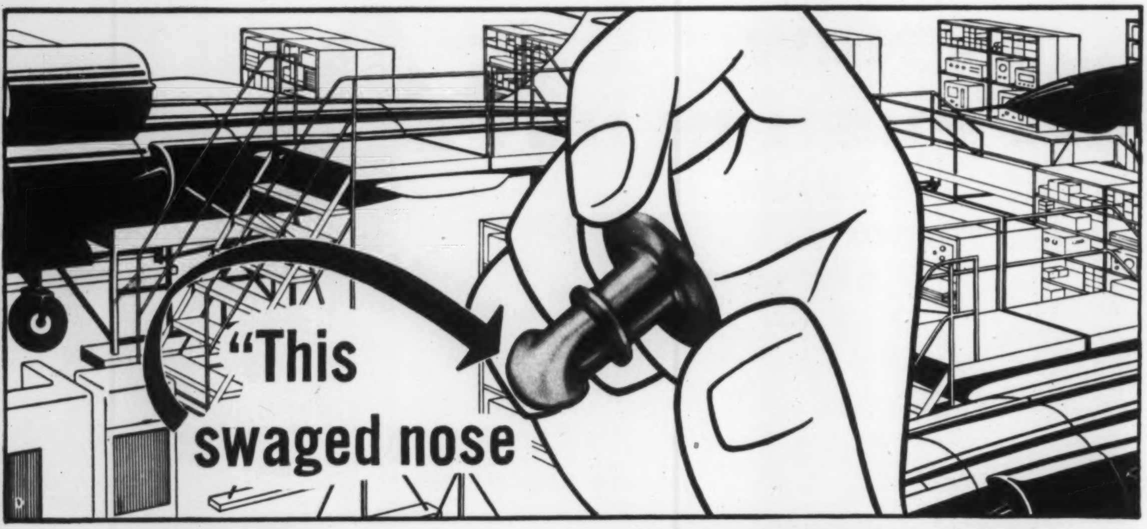

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is the secret of reliability, a high strength-weight ratio and smooth, positive operation."

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Lion Fasteners consist of three parts . . . a one-piece, swaged-nose stud having no cross pins to install or to become misaligned; a retainer; a floating receptacle which is riveted or welded in place. Installation requires no special tools . . . is simplified by a permissible float of .070".

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Full range of heads offers flush, oval, wing, ring, knurled, and notched head and key.

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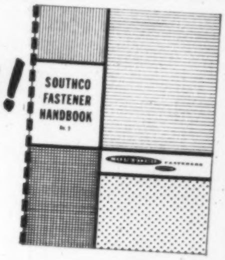

Send for your free copy of Southco Fastener Handbook No. 8. Gives complete engineering data on Lion Fasteners and many other special fasteners. Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

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Circle 513 on Page 19

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choose from the
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Available for immediate shipment from stock for over 90% of all applications

Only Hydro-Line offers you the "Complete Line" of three series of industry standard, modern design cylinders enabling you to choose the type best suited to your job requirements. You needn't pay for "too much" cylinder for the job, nor do you have to "stretch" and risk tying up production by not buying "enough" cylinder.

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Here are the three standard Hydro-Line series that combine the newest ideas in cylinder design with proved performance in all classes of industrial service:

series R2 — 200 psi air, 500-2500 psi hydraulic, 1½" to 14" bores; meet J I C standards.

series N — 2000 psi and higher hydraulic service; 1½" to 12" bores; meet J I C standards.

series S2 — 200 psi air, 1000 psi hydraulic, ½" to 8" bores; meet J I C and automotive industry automation standards.

For more complete data on sizes carried in factory stocks — covering 90% of applications and including thousands of bore, stroke and cushion combinations, contact your nearby Hydro-Line representative or fill in coupon below and send direct to factory:

Please send me additional data on the classes of Hydro-Line cylinders checked below, including complete information on deliveries from factory stocks:

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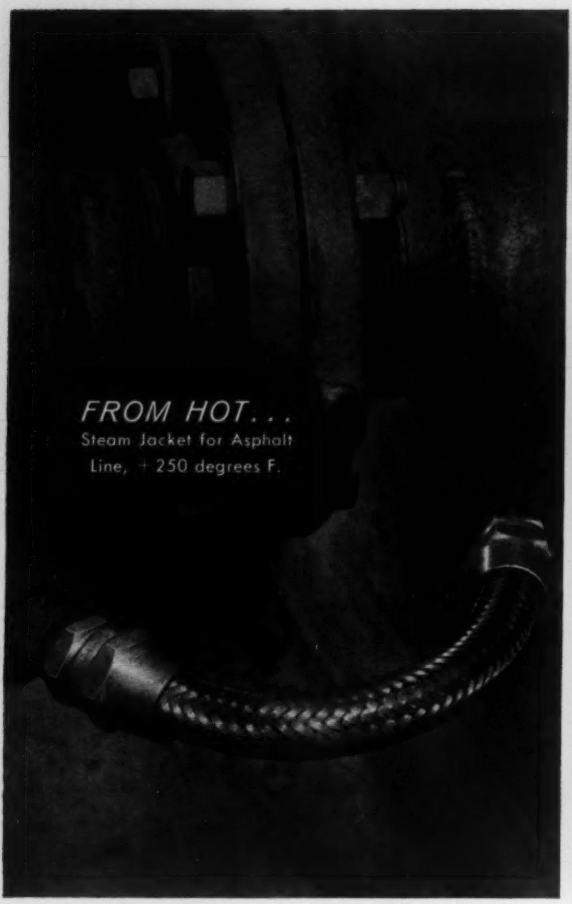

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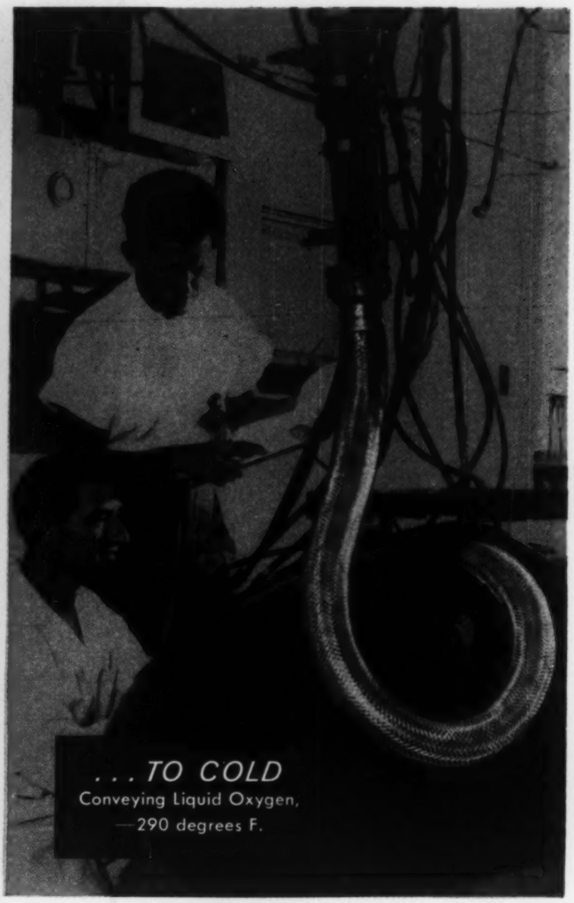
Steam Jacket for Asphalt Line, + 250 degrees F.



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Bring all your metal hose requirements to the one source that can meet the need *fully*—with *lower cost*, faster delivery. Whatever the medium to be conveyed, the pressure, temperature, motion or corrosive factor, FLEXONICS has the answer . . . in the construction, material and size (3/16″ to 24″ I.D.). Depend on this unique, full-range capability.

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Circle 515 on Page 19

Circle 516 on Page 19→

If your plans demand the best bronze, **specify Federated Engineered Bronze *by name!* As you know, the truly engineered bronzes—silicon, aluminum, and manganese—offer combinations of properties not available in other metals. Federated's extensive facilities deliver the precise qualities wanted. Continual controls during alloying under the direction of metallurgical specialists, assure performance that always meets, often exceeds, specifications. Call one of Federated's 21 sales offices for information about Federated Engineered Bronzes, conveniently produced in Los Angeles, Whiting, (Ind.), Perth Amboy, (N. J.), San Francisco, Houston. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.**

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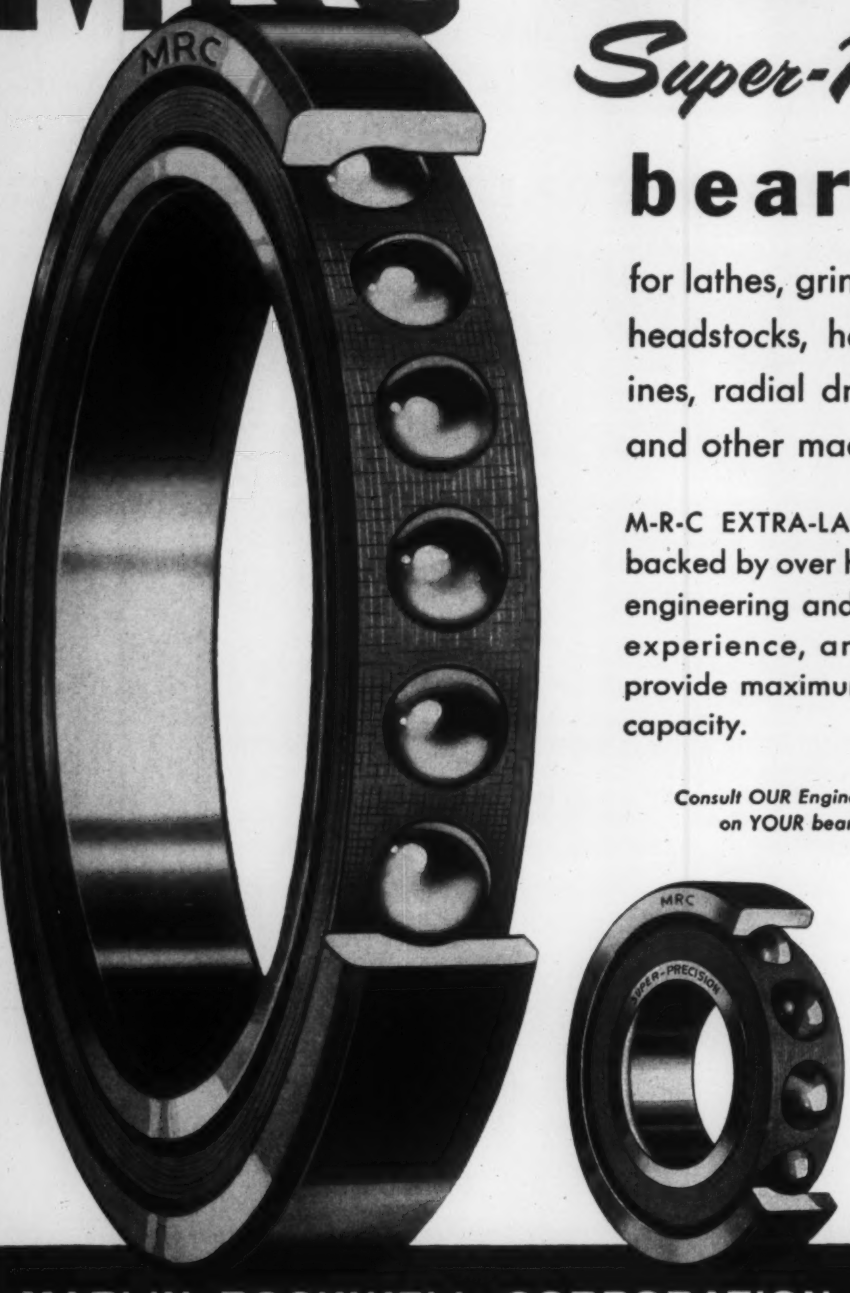

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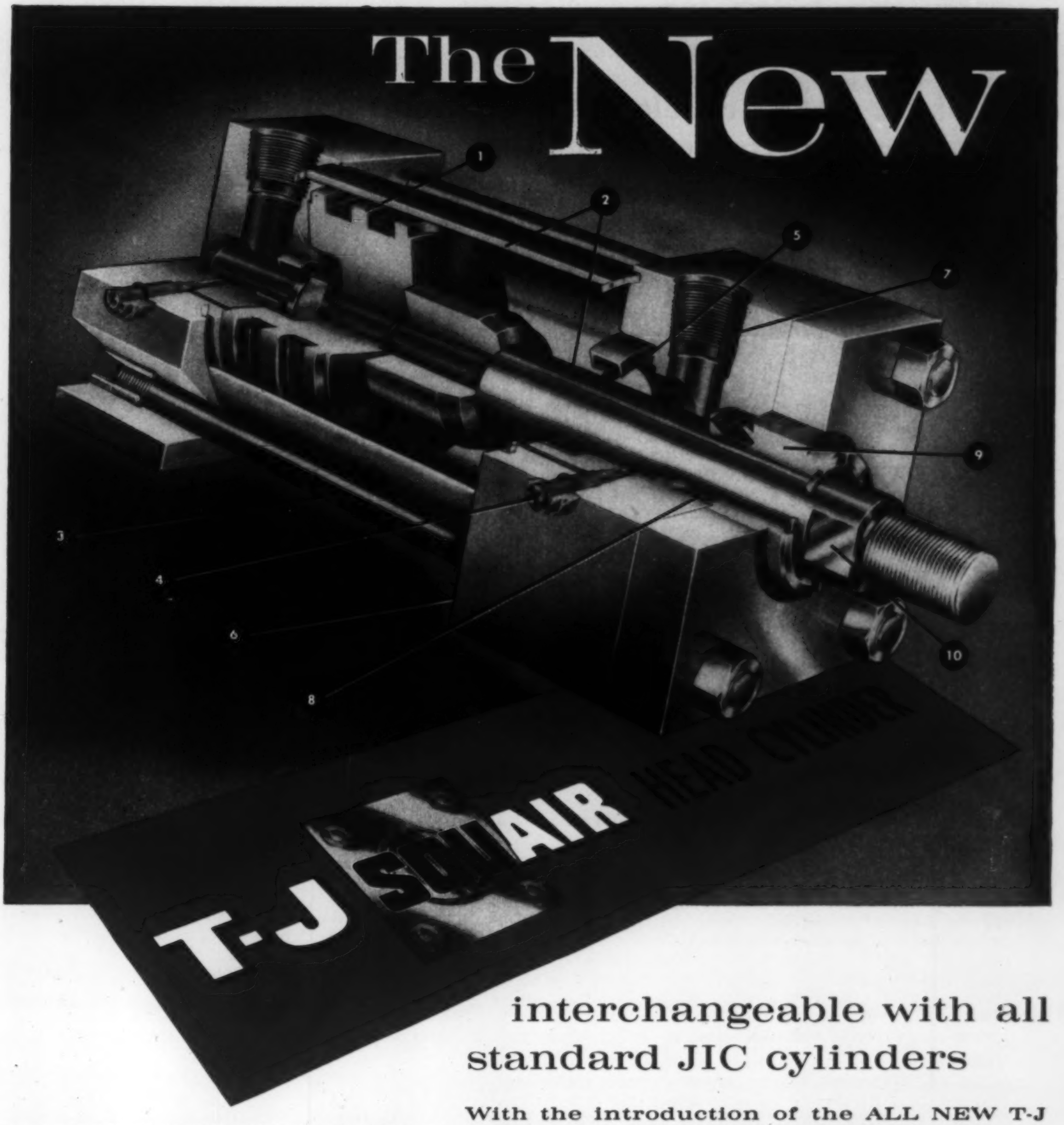


interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures . . . and is also adaptable to the use of low pressure oil as the working medium. Write to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

CHECK THESE 10 POINTS OF T-J SUPERIORITY

1 One Piece Piston

2 Hard Chrome Cylinder Bore and Piston Rods

3 High Tensile Steel Tie-Rods

4 Cushion Adjusting Screw, Externally Adjustable

5 New Super-Cushion for air, or Self-Aligning Master Seal for Oil (T-J Patents)

6 Solid Steel Heads and Mounting Plates Standard all Models

7 Port Design Allows Minimum Pressure Drop on Inlet or Outlet

8 Chevron Type, Self-Adjusting Rod Packing

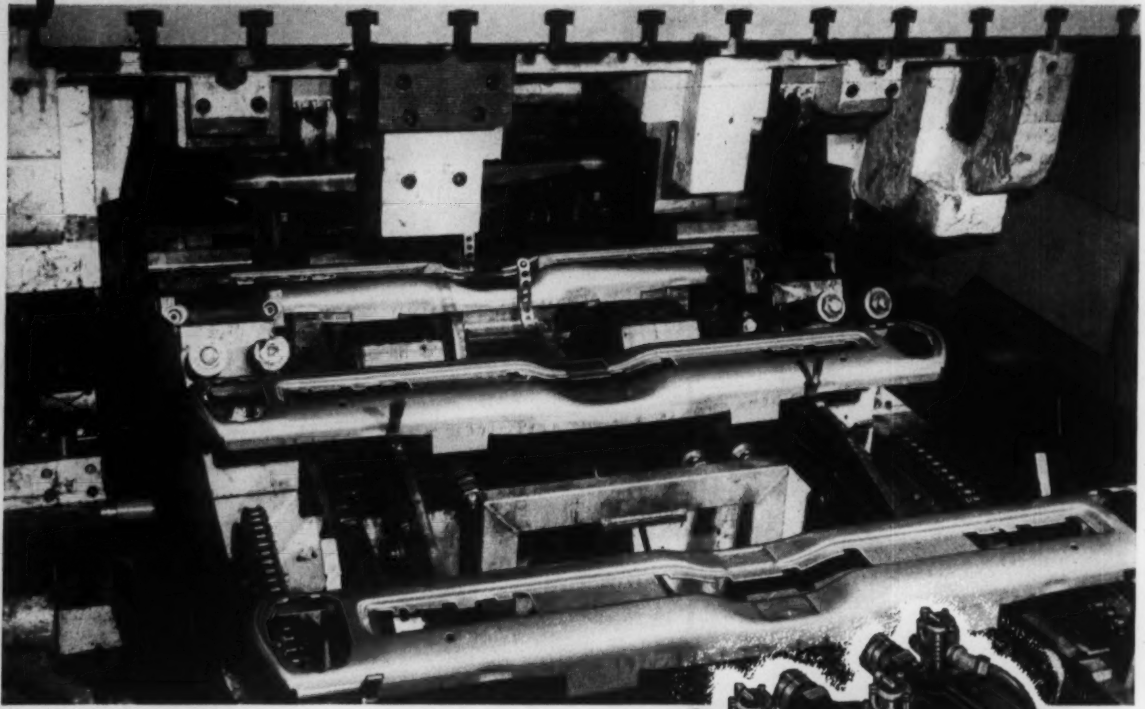
9 Piloted Packing Gland—Absolute Alignment

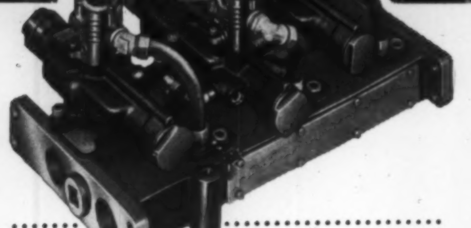
10 Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J
TOMKINS-JOHNSON
[illegible]

Circle 518 on Page 19

Valvair® deceleration manifolds provide safe, velvet-smooth control of high-speed press transfer shuttles





Performance of Valvair deceleration manifolds on press transfers maintains a steady high rate of production through a major automotive manufacturer's fully-automated 5-press stamping line. Valvair design assures necessary rapid movement of the transfer mechanism, with precisely controlled deceleration of the 200 lb. shuttle at each end of the cycle. And, positive cushioning of shuttle travel prevents damage to the transfer mechanism . . . protects valuable dies.

Valvair's deceleration manifold assembly uses only three SPEED KING valves; two to control cylinder movement, and one as a directional valve to select free or restricted exhaust for cushioning. Just two limit switches are needed to control cushioning action — a quick adjustment of exhaust restriction precisely regulates cushioning rate. Simplicity of design, plus SPEED KING multi-million cycle dependability, assures peak production rates, with minimum in-service downtime.

If control of fast-moving reciprocating mechanisms is a problem in your plant, ask your nearby Valvair representative for his recommendations. He's only a telephone call away.

This press transfer indexes 26 in. per cycle, at a 1,000 cycle/hr. rate. Valvair's compact, 3-valve deceleration manifold controls its horizontal movement . . . requires minimum mounting space . . . simplifies piping and wiring.

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co.
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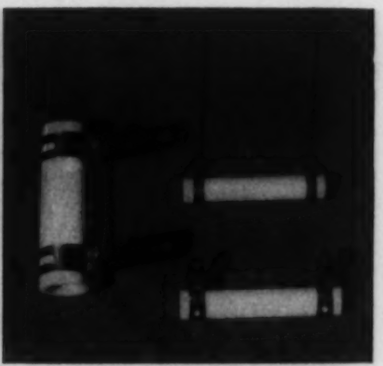
For more information, write for Bulletin G-3A. Address Dept. MD559, Valvair Corporation, Akron 11, Ohio.

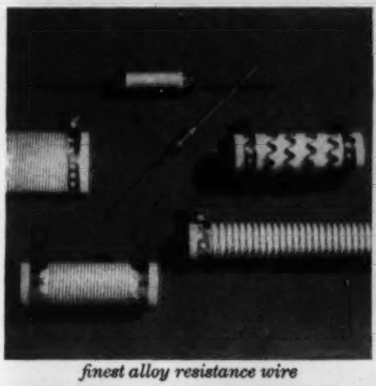
8018

tough tests for incoming material

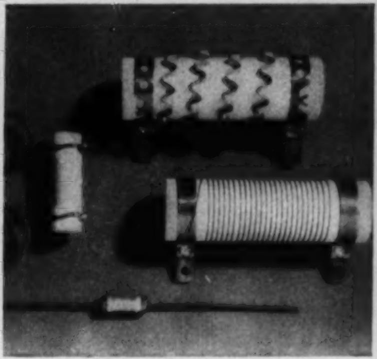
specially selected ceramic core materials



rigid, low resistance terminals

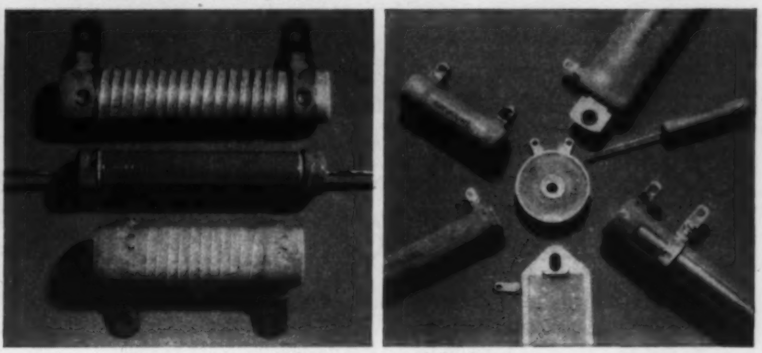


finest alloy resistance wire



spot welded or silver brazed junctions

THIS IS A RESISTOR YOU CAN STAKE YOUR REPUTATION ON



our own VITROHM enamel, first coat . . . and final coat

Built-in VITROHM reliability, from core to final vitreous enamel, lets you solder these resistors in and forget 'em

They come in a tremendous variety of sizes, shapes and ratings, but all Ward Leonard VITROHM resistors have one thing in common: They're built for maximum reliability.

Take just one point—ceramic cores, for example: Made by Ward Leonard to exacting specs, the cores feature low-porosity, high-dielectric-strength ceramic for maximum moisture exclusion and good electrical insulation. What's more, the thermal coefficient of linear expansion of ceramic is specially selected to make the core compatible with resistance wire, enamel and terminals . . . to prevent cracking, crazing, peeling, or layer separation.

And there's the same meticulous care with all the other elements that go to make up a finished VITROHM resistor: terminals, spot welded or brazed junctions, resistance wire, and last but not least, W/L VITROHM enamel, formulated and manufactured in our own modern enamel smelting plant . . . provides complete electrical and mechanical protection.

To insure reliability in your product . . . specify VITROHM's. Write for data packed catalog #15, and list of stocking Electronic Distributors: Ward Leonard Electric Co., 58 South Street, Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 9.4

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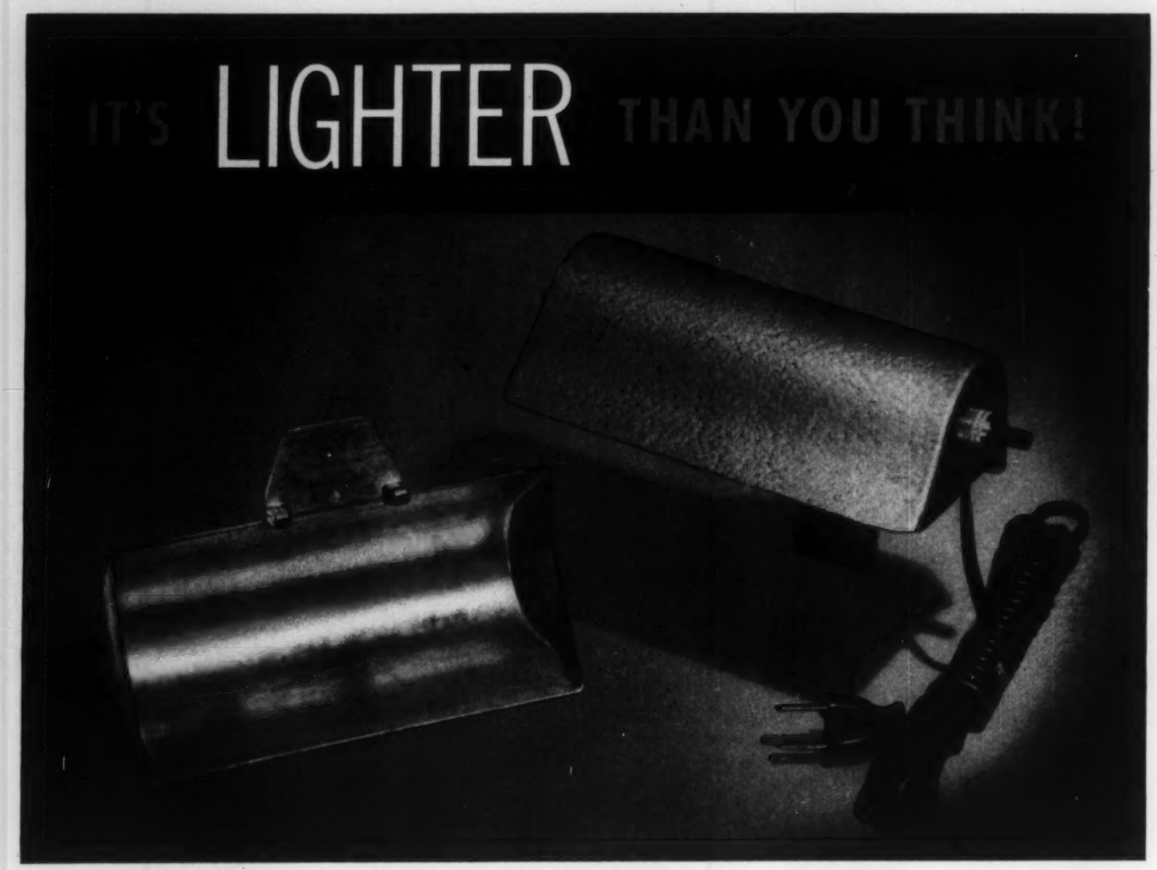


AND EASY TO ASSEMBLE WHEN DIE CAST WITH... ZAMAK

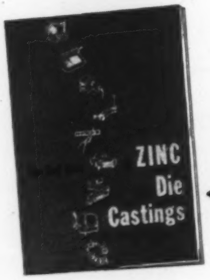
The shade for this new KLIP-LITE* music stand is made of a single thin-wall zinc die casting—for light weight and low-cost assembly. As thin as a stamping but with far greater rigidity, the contours could not be duplicated in sheet metal.

By designing for die casting, only 4 holes are needed before spray finishing and assembling the socket-switch and mounting bracket.

These extremely thin wall sections—possible only with ZINC die castings—minimize weight and are stronger in proportion to thickness than heavier sections.

Parts designed for ZAMAK alloy die casting will meet competition of either stampings or aluminum castings—and at lower cost.

*Made by WIESE MANUFACTURING COMPANY—Davenport, Iowa.



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THE NEW JERSEY ZINC COMPANY

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

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HORSE HEAD PRODUCTS ®

Circle 521 on Page 19

MACHINE DESIGN
May 14, 1959

Talent Unleashed

TO SUPERVISE or not to supervise—that is the question that faces many an engineer at a critical stage in his career. According to the "parallel paths" notion, an engineer should be able to progress to equal status whether he chooses to do strictly engineering work himself, or to supervise the work of other engineers. In practice it isn't always that simple.

To some the more rewarding path seems to lie in supervision. Yet engineers who choose that path sometimes regret exchanging satisfying engineering problems for the more frustrating problems of managing people. And sometimes a brilliant engineer ends up as a mediocre manager.

On the other hand, those who continue on the engineering path often find themselves bogged down in clerical details and record-keeping, or in subprofessional chores that a good technician could handle at half the salary. So why not hire competent clerical and technical aides to back up the engineers?

Alert companies are doing just that. In his article beginning overleaf, Jay Bergen tells how engineering technicians are integrated into a research and development organization. It's a workable plan, and sets a pattern which others might profitably emulate.

Are good technicians plentiful? Probably not. But the intellectual and educational requirements are less stringent than for engineers. The source of supply is larger and the training period shorter.

If the demand builds up, business schools and technical institutes will respond. At least one business school already is turning out secretaries specially trained as engineering assistants. And if other schools and institutes can be assured that engineering technician jobs will be available for their graduates, they will promote and develop the necessary courses.

It is no less than utmost extravagance to require a creative engineer to spend any of his time on routine, noncreative procedures. Only with proper technical assistance can such an engineer develop his full potential and earn a top salary. Then, and only then, will the engineering path be irresistably attractive to top-flight engineering talent.

Colin Carmichael
EDITOR

Engineering Technicians . . .

- **What training should they have?**
- **What can they do?**
- **How do they work with engineers?**
- **Where do they fit on the salary scale?**

Here's how one company answers these questions.

JAY H. BERGEN
Director
Engineering Services Laboratory
American Machine & Foundry Co.
Stamford, Conn.

PUTTING

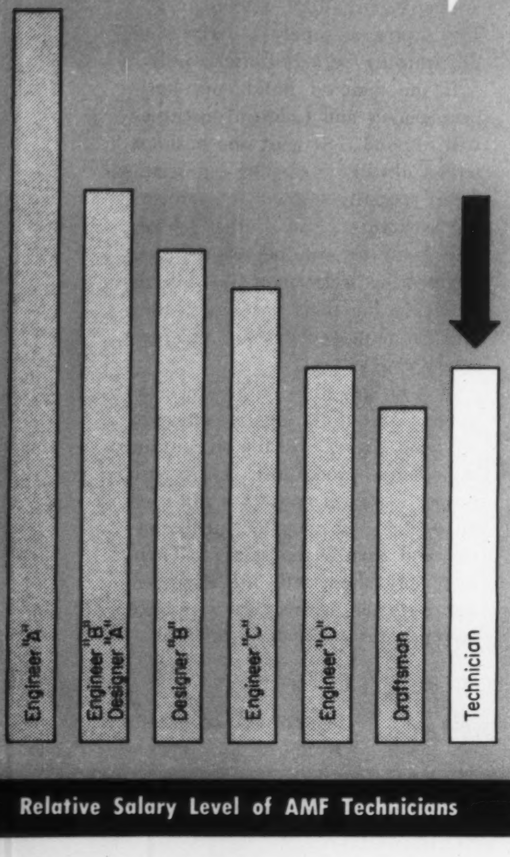
CAPABLE engineers are too often tied down to the performance of routine tasks. Creative personnel can be so hamstrung by organization matters that they have little time left for concentration on their real jobs. A practical solution is to assign technical assistants to take over the time-consuming chores of writing reports, attending general meetings, and handling co-ordination.

Back-up personnel for research and development engineering groups include technicians, draftsmen, illustrators, model makers, and test equipment assemblers, as well as clerical personnel. Of these, the technician is the most important in that he can be the most versatile and, when trained to work within the engineer's sphere of interest, the most helpful.

WHAT is a technician, precisely? The National Science Foundation defines him this way: "Those workers who aid professional scientists and engineers in research or development work and who are in positions requiring knowledge of the sciences, engineering, and mathematics comparable to that acquired through technical institute, junior college, or other formal, post high-school training."

At American Machine & Foundry Co., job description for an engineering technician states that he must have a broad knowledge, equivalent to at least two years of technical college, of an engineering field (such as machine design or electronic design), shop practice, and production methods associated with mechanical or electrical products. Depending upon individual background, a technician may be placed in a salary grade equivalent to a subprofessional designer or engineer "D."

In the AMF scheme of operation, the engineering technician plays an important, although varied,



Relative Salary Level of AMF Technicians

TECHNICIANS TO WORK

in research and development projects

role. The company's engineering activities are diverse. They range from the manufacture of capital and consumer goods to basic research and development in advanced fields of technology. Hence, there are no hard and fast rules which apply to the entire organization. However, certain established policies and procedures are adhered to as closely as possible by individual, local plants or groups.

A GOOD example of how technicians are employed to advantage in research and development activities can be shown by tracing a typical project through AMF's stage system. The stage system may be defined as the scheduling of development activities for the purpose of measuring and controlling progression in the evolution of an engineering project. It provides an orderly basis for formulation of project objectives, specifications, and time and cost estimates, as well as for the preparation of manpower schedules and budgets, and for the assignment of personnel and operating responsibility. It further provides for continuing evaluation of performance in terms of techniques, time, cost, and adherence to stated objectives.

Although well-established as standard procedure at AMF, the stage system is intended to be modified to suit specific projects or situations. There can be no hard and fast rule for the employment of technicians on any project. But there are certain areas where technicians and even clerical personnel can be used effectively to relieve trained engineering personnel from routine matters.

ORGANIZATION of a stage system for a typical engineering project is outlined in *Engineering Project Stages*. Marginal notes indicate how and where technical assistants can be employed to advantage in the various stages from project inception through release to production.

Fundamental principles of this stage-system approach are summarized in the following sections. The same concepts can be applied to almost any project where experienced technical personnel are employed.

Stage 1: In the preliminary engineering-analysis stage of a project, a survey must be made to evaluate the technical feasibility of a project and its overall requirements, including performance, appearance, size, weight, service, cost, and all other pertinent factors. Considerable data must be collected and presented for evaluation.

Much of this information collecting represents routine investigation and compilation, which can be readily accomplished by an engineering technician. Such a person or group of persons can study and evaluate higher technical art in the area of the project involved, perhaps to the point of reviewing patents and competing products or processes, both existent and potential.

Stage 2: The engineering-exploration stage consists of an investigation to select the most practical scheme of developing the product or process and to prove the technical feasibility of the principles involved. All of the findings of the previous stage are re-evaluated and a thorough study of possible alternative development schemes is initiated. During this period, the technician can be of assistance as an information gatherer.

In this stage, outlines of the project are made, including schematic diagrams and sketches. Included are preliminary design, construction and test of jury rigs or experimentation with processes and

Engineering Project Stages

As defined at American Machine & Foundry Co., the stages in the evolution of an experimental engineering project, together with the principal types of work normally performed under each stage, are:

Approximately 30% of this effort may be assigned to technicians; for example, collection of information on prior art and estimates, discussions with manufacturing and other engineering departments such as design.

Stage 1—Engineering Analysis: An engineering survey to evaluate the technical feasibility of the project, concurrent with or subsequent to commercial analysis. Includes:

1. Study and evaluation of requirements, including performance, appearance, size, weight, service, cost, and other pertinent factors.
2. Study and evaluation of prior technical art, including a review of patents and competing products or processes, both existent and potential.
3. Study and evaluation of possible alternative schemes of developing product or process, including:
   - 3.1. Preliminary estimate of the time and cost of developing each alternative.
   - 3.2. Engineering opinion of the approximate tooling and manufacturing cost of each alternative.
   - 3.3. Engineering opinion of possible financial return.
4. Preparation of a report to include:
   - 4.1. Summary of findings.
   - 4.2. Analysis of critical and limiting technical elements.
   - 4.3. A set of preliminary specifications.
   - 4.4. Detailed recommendations as to course of action to be followed, including estimate of funds required for Stage 2, and appropriation request, if any, for Stage 2.

One or more technicians might be assigned full time to follow design and construction of jury-rigs or process tests, and to gather information for project engineer's analysis.

Technician can assist project engineer in compiling infolmation.

Stage 2—Engineering Exploration: An investigation to select the most practicable scheme of developing the product or process, and to prove the technical feasibility of the principles involved. Includes:

1. Thorough study of possible alternative development schemes.
2. Preparation of schematic diagrams and sketches.
3. Design, construction and test of jury rigs, or experimentation with processes and test of process samples, or other similar work that may be required to prove the feasibility of principles involved.
4. Check for potential patents and/or infringements.
5. Preparation of a report to include:
   - 5.1. Revised estimate of time and cost to complete the project.
   - 5.2. Revised engineering opinion of the approximate tooling and manufacturing cost.
   - 5.3. Revised engineering opinion of possible financial return.
   - 5.4. Summary of work completed and results obtained.
   - 5.5. Evalution of potential technical success.
   - 5.6. Revised specifications for approval, including cost, performance, appearance and design specifications, such as size, weight, maintenance, service, etc.
   - 5.7. Recommendations as to future action, including estimate of funds required for remaining stages of project, and appropriation request, if any, for Stages 3, 4, and 5.

Technician may spend up to 100% of his time conveying jury-rig information to design, following job progress, working on model construction, and carrying on liaison with manufacturing.

Stage 3—Prototype Design: Incorporation of principles established under Stage 2 into a practical design which will meet the approved specifications, and preparation of detailed drawings for manufacture of prototype. Includes:

1. Preparation of layouts.
2. Construction of a scaled dummy model (when necessary).
3. Consultation with industrial designer.
4. Consultation with factory engineeers.
5. Preparation of detail drawings.
6. Check for potential patents and/or infringements.
7. Preparation of a bill of material.
8. Preparation of report to include:
   - 8.1. Evaluation of progress to date and outlook for the future.
   - 8.2. Tentative tooling and manufacturing cost estimates.
   - 8.3. Comparison of design with specifications.
   - 8.4. Recommended future action.

Major portions of shop and purchasing department liaison and operational testing may be assigned to technicians.

Stage 4—Prototype Construction: Fabrication of prototype in accordance with the drawings and bill of material prepared in Stage 3. (Costs collected against this stage will include shop cost only; cost of engineering liaison and changes will be charged to Stage 3). Includes:

1. Shop labor and materials for fabrication.
2. Operational tests by shop personnel.
3. Modifications necessitated by engineering changes.
4. Engineering liaison with shop.

Stage 5—Prototype Test: Prototype testing in shop under simulated operating conditions and/or in the field under actual operating conditions. Includes:

1. Establishment of standard test specifications.
2. Installation and operation of prototype.
3. Compilation and evaluation of test data.
4. Minor alterations as required to conduct tests.
5. Preparation of a report to include:
    5.1. Evaluation of test results and comparison with specifications.
    5.2. Recommended design changes.
    5.3. Recommended specifications for pilot production models.
    5.4. Revised tentative tooling and manufacturing estimates.
    5.5. Recommended future action, including appropriation requests, if any, for Stage 6.

Approximately 50% of these four steps may be performed by a technician under direct supervision of an engineer.

Stage 6—Pilot Production Model Design: Design modification to incorporate changes approved from Stage 5, and to reduce manufacturing costs to the minimum. Includes:

1. Consultation with industrial designer.
2. Consultation with factory engineers.
✓3. Preparation of layouts.
✓4. Preparation of detail drawings.
✓5. Preparation of assembly drawings.
6. Check with Patent Department.
✓7. Preparation of a bill of material.
8. Reduction in costs through simplification of design and methods, substitition of materials, etc.
✓9. Preparation of manufacturing and tooling cost estimates by factory.
10. Preparation of a report to include:
    10.1. Evaluation of progress to date and outlook for future.
    ✓10.2. Tooling and manufacturing cost estimates.
    10.3. Comparison of design with specifications.
    10.4. Recommended future action, including appropriation request, if any, **for Stages 7, 8, and 9.**

30 to 60% of the work in this stage may be done by technicians. Major assistance is provided by following the items checked.

Stage 7—Pilot Production Model Construction: Fabrication of pilot production models by the factory in accordance with the manufacturing drawings and bill of material prepared in Stage 6, and using tools prepared for the production run, to insure that all engineering errors are corrected and to check manufacturing cost estimates, before a large lot is built. (Costs collected against this stage will include shop costs only; cost of engineering liaison, changes and report will be charged against Stage 6.) Includes:

1. Factory labor and materials for fabrication.
2. Operational tests by factory personnel.
3. Modifications necessitated by engineering changes.
4. Engineering liaison with factory.
5. Preparation of report to include:
    5.1. Evaluation of design, particularly from manufacturing standpoint.
    5.2. Estimation of actual manufacturing cost compared with previous estimates.
    5.3. Recommended future action.

Here, the technician may handle about 90% of the shop liaison and can do most of the legwork involved.

Stage 8—Pilot Production Model Test: Pilot production models testing in factory under simulated operating conditions and/or in the field under actual operating conditions. Includes:

1. Establishment of standard test specifications.
2. Installation and operation of pilot production models.
3. Check with Patent Department.
4. Compilation and evaluation of test data.
5. Minor alterations as required to conduct tests.
6. Impartial evaluation.
7. Preparation of a report to include:
    7.1. Evaluation of test results and comparison with specifications.
    7.2. Recommended design modifications, classified into those required for first production lot and those deferable.
    7.3. Recommended final specifications.
    7.4. Recommended future action.

Probably 70 to 80% of the work in these four areas can be performed by technicians under the supervision of engineers.

The technician also can assist in reviewing progress to firm up these recommendations

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Stage 9—Preparation for Manufacture: Final revision and checking of drawings, bill of material, and other instructions for economic lot manufacturing, and compilation of technical data for sales and service. Includes:

1. Checking and finalizing of drawings and bill of material.
2. Preparation of engineering-manufacturing Instructions.
3. Preparation of technical data folio including necessary information for installing, operating, and servicing unit.
4. Training of service personnel, including establishment of form desired for field reports.
5. Release of drawings for manufacture.
6. Preparation of final report to include:
    6.1. Review and evaluation of engineering performance of the project.
    6.2. Recommendations as to handling of other development projects.

Technicians would be able to handle the major effort in these areas.

tests of samples, and other similar work that may be required to prove feasibility of principles. Here, designers and draftsmen also can be called upon.

At the close of this stage, a report is prepared on such major items as a complete estimate of time and cost to complete the project and engineering opinion of the approximate tooling and manufacturing costs. The report includes details of status of work completed, results obtained, and evaluation of potential technical success, as well as the design specifications and recommendations for future action. While personnel on the graduate level must necessarily make the decisions, it has been shown many times that technicians can do a satisfactory job of preparing information for analysis.

Stage 3: The prototype-design phase provides for the incorporation of principles established in stage 2 into a practical design which meets the approved specifications, and for the preparation of detailed drawings to permit manufacturing of a prototype unit. Work in this stage involves preparation of layouts, construction of a scale model if necessary, consultation with manufacturing engineers, and preparation of detailed drawings, specifications, bills of materials, and a report which includes evaluation of progress in the stage and tentative tooling and manufacturing-cost estimates.

In this stage an even larger percentage of the actual work can be performed by technicians, draftsmen and others below the graduate level.

Stage 4: Construction of the prototype offers still greater opportunity for employment of technicians. Here, the work is accomplished under direct supervision of engineers. At the end of this stage, operational tests are conducted by shop personnel and technicians. With the guidance of the engineers in charge, necessary modifications may be executed.

Stage 5: The prototype is now tested in the shop under simulated operating conditions and/or in the field under actual operating conditions. With the aid of a technician, the engineer establishes standard test specifications and supervises both the installation and the operation of the prototype.

While actual tests are under way, the technician can perform most of the compilation, submitting test results to the engineer for evaluation. Spotting and correcting minor alterations to the prototype are responsibilities of both the engineer and the technician.

The report at the end of this stage evaluates results and compares them with the specifications originally established. Recommendations are made for any design changes to improve the product.

If required, specifications are revised so that they will apply to pilot-production models. Tooling and manufacturing estimates are brought up to date. In all phases of this stage, the technician comes close to being full partner to the engineer.

Stage 6: Once the testing of the prototype has been evaluated, design of the pilot-production model begins. In the first portion of this stage, the engineer consults, if necessary, with industrial designers and factory engineers, and supervises the preparation of layout drawings for the pilot-production model.

Then, technicians take over. They assist in the preparation of detail and assembly drawings, help in checking with the patent department, and prepare bills of materials. Meanwhile, the engineer in charge makes a study of possibilities for cutting costs in methods or in substitution of materials through simplification of design.

Following this investigation, the technician prepares manufacturing and tooling-cost estimates with the assistance of manufacturing personnel. At the close of this phase, the engineer and technician evaluate progress and prepare a report for review by management.

Stage 7: Construction of the pilot-production model is the next step. In this stage, technicians maintain liaison between engineer and manufacturing group.

A principal reason for a pilot-production run, of course, is to assure that all engineering errors are corrected and to check manufacturing costs, as well as to suggest possible modifications before the equipment is built in quantity. Throughout this stage, the technician can save the engineer many hours in routine operations.

Stage 8: As in the development of the prototype unit, when the pilot-production model is ready to test, the engineer supervises test preparations while the technician establishes test specifications, supervises installation, and establishes procedures for operation of pilot-production equipment. Together, the technician and engineer compile and evaluate test data.

At this stage the engineer suggests such minor alterations as may be required, and conducts an impartial evaluation of the pilot-production model. Then, the engineer, with the help of technicians, recommends design modifications and draws up final specifications for the equipment.

Stage 9: Last step of the stage system is the preparation of equipment for full-scale manufacturing. Final revisions and checks of drawings are made. Additions and changes to bills of materials, last-minute production preparations, and compilation of sales and service data are completed.

Here, technicians supervised by engineers can do nearly all of the checking and finalizing of drawings and bills of material, as well as the preparing of data for installation, operation and servicing. They also can help to train service personnel and to establish such forms as may be required for field reports.

At the completion of this stage, a final report is written to include a complete review and evaluation of engineering performance on the project, along with recommendations for handling of other development projects of the same nature.

When these nine stages are carried out under close to ideal conditions, the trained engineer is free to make best use of his capabilities. Under the same conditions, technicians can be employed to maximum advantage.

At times, of course, junior engineers who are on their first assignments, can take the place of technicians to gain experience. In some instances, draftsmen who have broad experience and training, can be employed off the drawing board with excellent results.

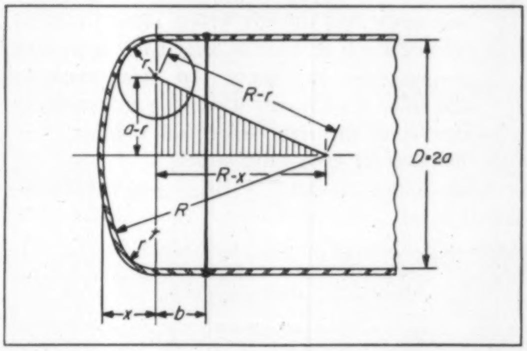
Based on experience at AMF, the technician can become a valuable and respected member of the engineering team if he is integrated properly into the working organization. So long as the areas of effort of engineers and technicians are clearly defined, friction between the two groups is almost nonexistent, barring, of course, the occasional personality differences which are inevitable.

Proper placement of technicians is all important. If the technician is not relieving an engineer of routine work, his value is close to nil. Before a technician can be effectively placed, the engineer's job must be reviewed carefully to identify sub-professional tasks.

Some companies start technicians on training programs which enable them to discover, through working for two or three months on assignments in several departments, where their chief interests lie. These programs also offer employers opportunities for evaluation and afford a period when professional and sub-professional can get acquainted.

Tips and Techniques

Pressure Vessels



The internal height, x, of the dished end of a pressure vessel can be easily calculated from

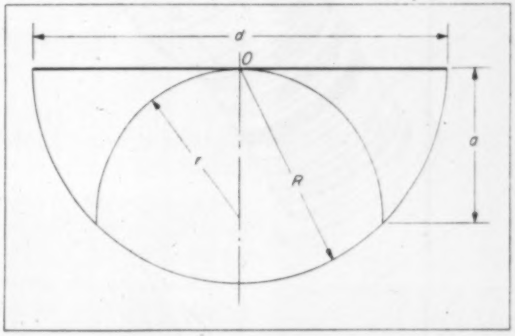
$$x = R - [(R - r)^2 - (a - r)^2]^{1/2}$$

where R = radius of dished end, in.; r = inside radius of corner, in.; and a = radius of vessel, in.—D. V. Dullberg, *mechanical engineer, Haifa, Israel.*

Finding Equivalent Spherical Areas

A simple construction can be used to convert a flat circular area into an equivalent spherical area to conserve space in designs where the over-all diameter is critical. Filters and valves are examples of such designs.

1. Draw the diameter, d, for a circle with the required area.
2. Draw an arc with radius R and center O.
3. From any point along a line perpendicular through O, draw any arc that will pass through O, and cut the semicircle about O. Distance a is the height and r is the radius of an equivalent spherical segment.



Any number of segments can be obtained by this method as long as $r \geqq R/2$ and $a \leqq r$. For this construction, $d = 2[a(2r - a)]^{1/2}$.—Richard Wadler, *engineer, Raytheon Mfg. Co., Bedford, Mass.*

Brake-Band Pressure

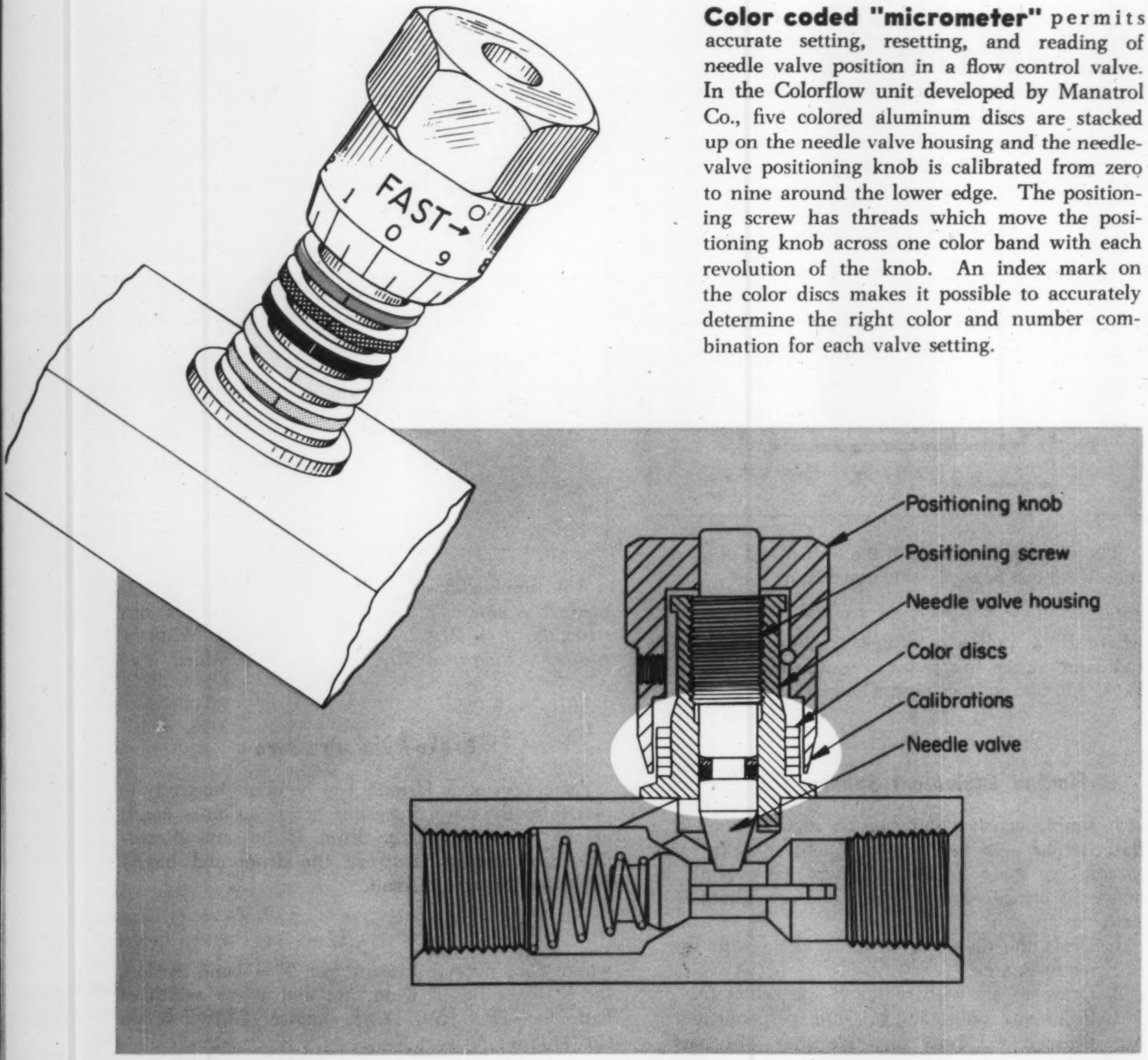
An approximate formula can be used effectively to determine the normal pressure acting on brake bands at any point around the drum. If the ratio of coefficient of friction (between the drum and band) to the band radius is small,

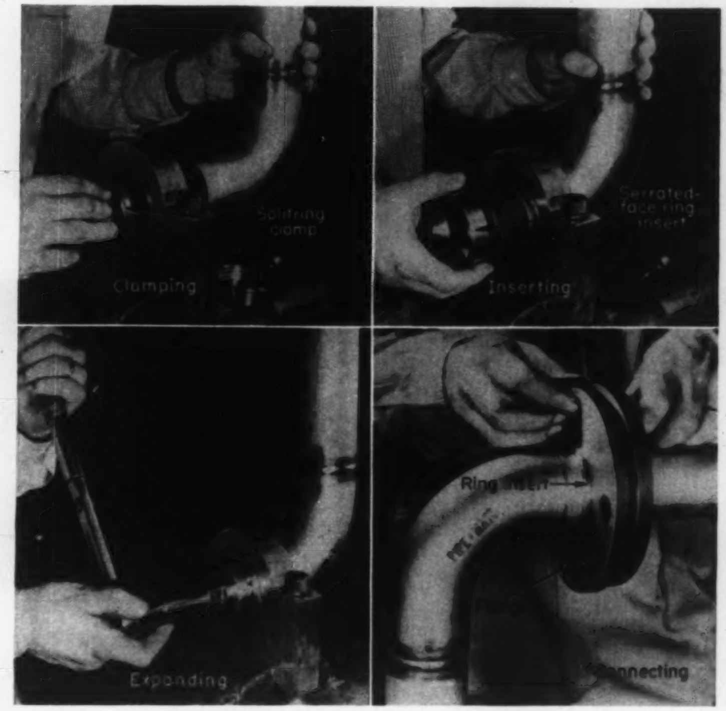
$$P = \frac{T}{RW}$$

where P = normal pressure, psi; T = band tension, lb; R = radius of band, in.; and W = width of band, in.—Donald B. Losse, *engineer, Gifford-Wood Co., Hudson, N. Y.*

scanning the field for *ideas*

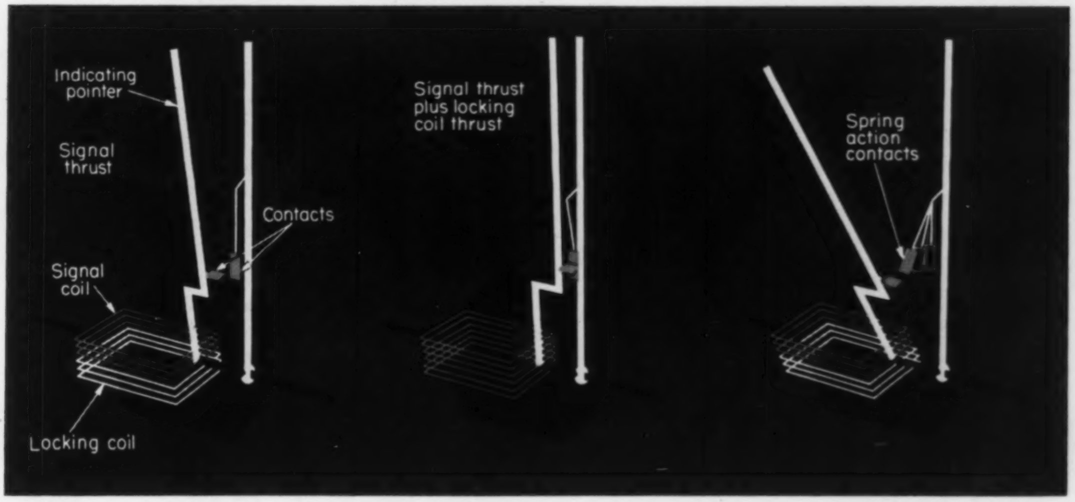
Color coded "micrometer" permits accurate setting, resetting, and reading of needle valve position in a flow control valve. In the Colorflow unit developed by Manatrol Co., five colored aluminum discs are stacked up on the needle valve housing and the needle-valve positioning knob is calibrated from zero to nine around the lower edge. The positioning screw has threads which move the positioning knob across one color band with each revolution of the knob. An index mark on the color discs makes it possible to accurately determine the right color and number combination for each valve setting.


FAST→
1
0
9
Positioning knob
Positioning screw
Needle valve housing
Color discs
Calibrations
Needle valve


Split-ring clamp
Clamping
Serrated-face ring insert
Inserting
Expanding
Ring insert
Connecting

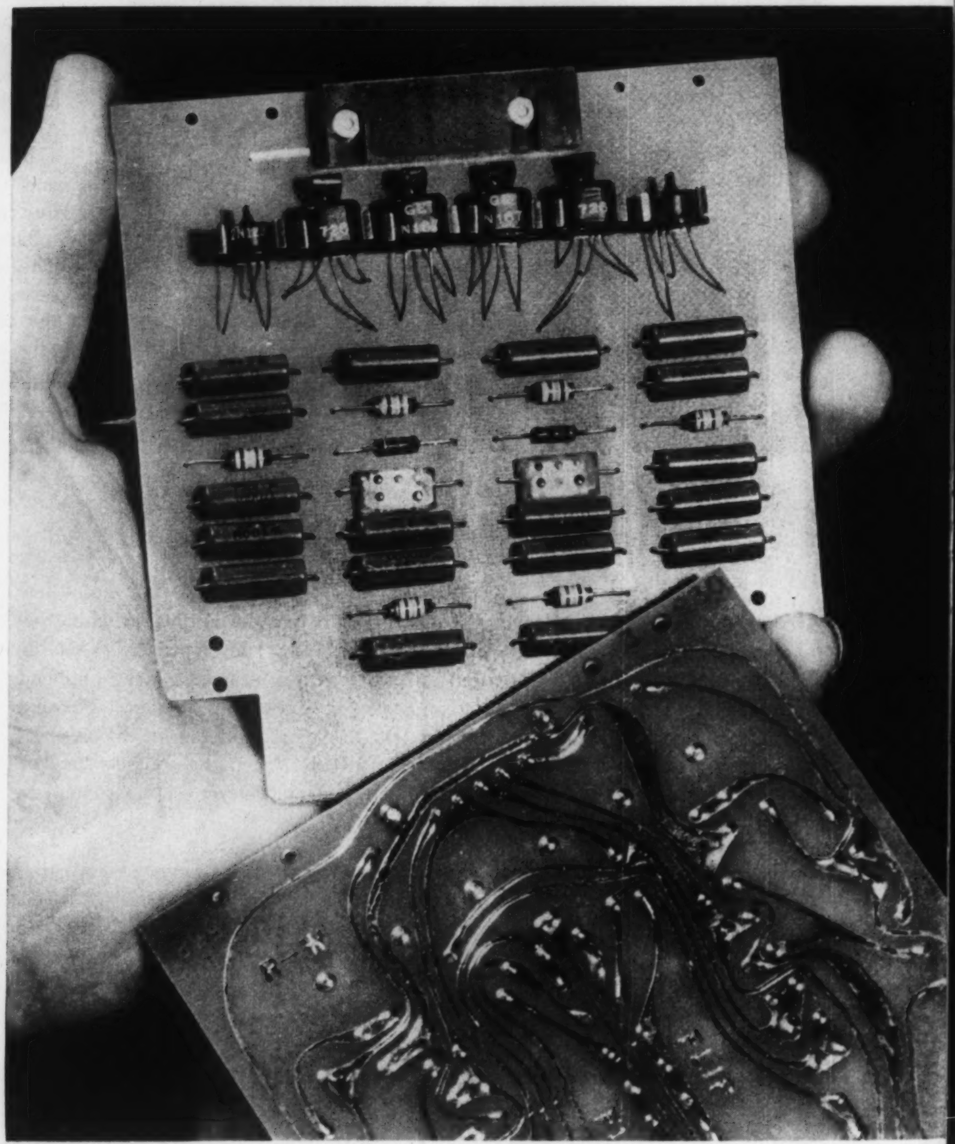
Flange retaining ring eliminates in-place welding of joints for thin-walled pipe or fittings in low-pressure, noncritical applications. The pipe or fitting is held in a split-ring clamp and is fitted with a serrated-face ring insert which has grooves on the ID. The end of the pipe or fitting is expanded into the insert and locked in place by the grooves. A lip on the insert mates with a groove in the flange face and the flange is rotated to line up with the bolt holes of a flange on a connecting pipe. The serrated face of the insert serves as the sealing face of the unit. A gasket is generally used to produce a leak tight seal. The design was developed by Tube Turns Div., Chemetron Corp.

High-torque coil supplements signal thrust to provide positive switching action in instrument control circuits. In a meter relay developed by Assembly Products Inc., a locking coil is wound integrally with a measuring coil. One end of the locking coil is connected to a contact on the indicating pointer. A second contact is spring mounted on a set-point arm. When the measuring coil is energized, torque produced causes the pointer to move. When the contacts "make" the locking coil is energized, producing a supplementary torque large enough to maintain positive contact.


Indicating pointer
Signal thrust
Contacts
Signal coil
Locking coil
Signal thrust plus locking coil thrust
Spring action contacts

Design Guide for

Mounting Electronic



Printed-circuit boards for the Ramo Wooldridge RW-300 digital control computer. Electronic components are mounted on front of each board and are held in place with dip soldering on back. Transistors are mounted in spring clips which are screw-fastened to the glass-based epoxy boards.

Components

FRANK WILLIAM WOOD Jr.
Design Engineer
Vitro Laboratories
Silver Spring, Md.

SIZE, shape, and weight play important roles in selection of the best way to mount electronic components. How securely a given component must be held in place is a major factor in many applications, particularly transportation equipment, missiles, rockets, etc.

Environment may well dictate which mounting method must be used. Also, such electronic parts as tubes, rectifiers, resistors, and chokes produce heat, and this factor enters into the mounting design.

Capacitors, crystal diodes, and some other components are sensitive to heat. They must be mounted as far as possible from heat-producing components.

Ratings of selenium rectifiers and transistors are affected by ambient temperature; therefore they should be mounted to permit the best possible cooling.

Snap-In Clips: Electronic equipment often requires quick assembly and disassembly or removal of components. For these reasons, snap-in type clip devices, such as shown in Fig. 1, are used widely today for mounting electronic components.

Quick-Release Clamps: Some electronic components such as tubes, transistors, and relays are designed for plug-in mounting, for maximum ease of replacement. The advantage of the plug-in feature of these components can be hidden or lost completely if a clamp-type retainer is selected which is not of a simple, quick-release design. Ideally, retainer clamps should not require tools to lock or release the plug-in component. Locking should be positive, and there should be no loose parts when the component is removed. Also, the retainer clamp should be located and mounted in such a way that it does not interfere with the removal of adjacent components. Three well-designed, quick-release

DESIGN CHECKLIST

Plug-In Components

- ☑ Is adequate space allowed for inserting and removing components?
- ☑ Is there enough space between adjacent components for swinging or pivoting quick-release, clamp-type retainers?

Wired-In Components

(transformers, resistors, capacitors)

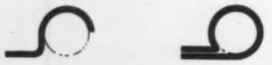
- ☑ Is component mounted to facilitate wiring and cabling?
- ☑ Is mounting hardware proportional to size of components?
- ☑ Are mounting brackets adequate to meet applicable shock and vibration specifications?
- ☑ Is adequate clearance provided between adjacent components to prevent damage from relative movement?
- ☑ Is component adequately supported by a mounting clamp or bracket? (Don't depend on pigtail leads alone for support!)
- ☑ Are components with exposed "hot" terminals spaced for adequate insulation?
- ☑ Is component located and mounted for best heat dissipation?
- ☑ Are components mounted for testing and maintenance accessibility?

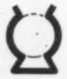
clamps for plug-in devices are shown in Fig. 2.

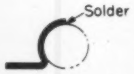
Wrap-Around Clamps: A number of wrap-around tube clamps, Fig. 3 and 4, are now available. Besides clamping, these devices also aid in heat dissipation and shielding of components.

Custom-Built Clamps and Brackets: Although numerous devices are commercially available for mounting and holding electronic components, many other types of clamps and brackets can be custom designed for specific components. Several ideas for such designs are shown in Tables 1 and 2 plus Fig. 5, 6, and 7.

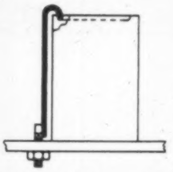
Table 1—Clamps and Mounting Brackets For Small Electronic Components

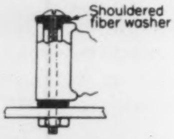

Clamps for capacitors or resistors

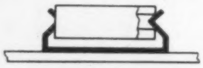

Spring clamp for capacitors, resistors, and transistors

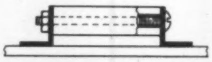


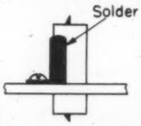
Clamp for soldering metal-case capacitor


Clamp for metal-case capacitor

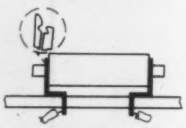

Shouldered fiber washer
Machine-screw "clamp" for hollow resistors

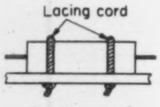

One-piece spring clips for hollow resistors

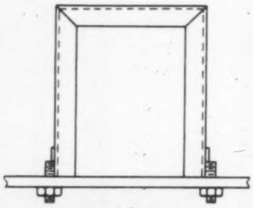

Angle-bracket supports for hollow resistors

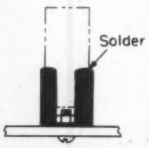


Mounting bracket for soldering to metal-case capacitor

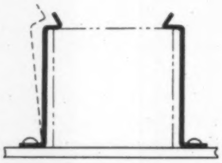

Snap-in clips for crystal diodes

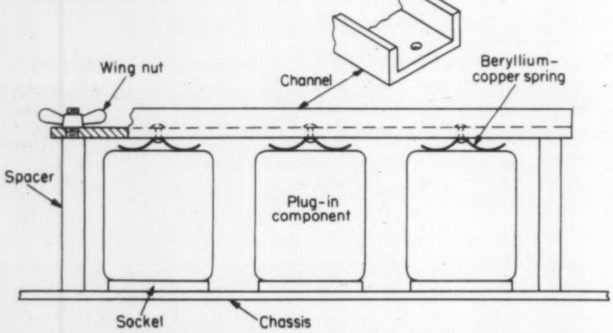

Lacing cord
Lacing-cord "mounting clamps" for capacitors

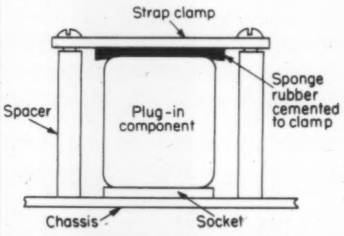

U strap with attached spade lug for capacitors and transformers



Holder for soldering to end of metal-case capacitor


Spring clips for plug-in components (crystals, relays, etc.)


Wing nut
Channel
Beryllium-copper spring
Spacer
Plug-in component
Socket
Chassis
Spring-loaded multiple-unit clamp for plug-in components


Strap clamp
Sponge rubber cemented to clamp
Spacer
Plug-in component
Chassis
Socket
Top clamp for plug-in components with sponge-rubber "spring"

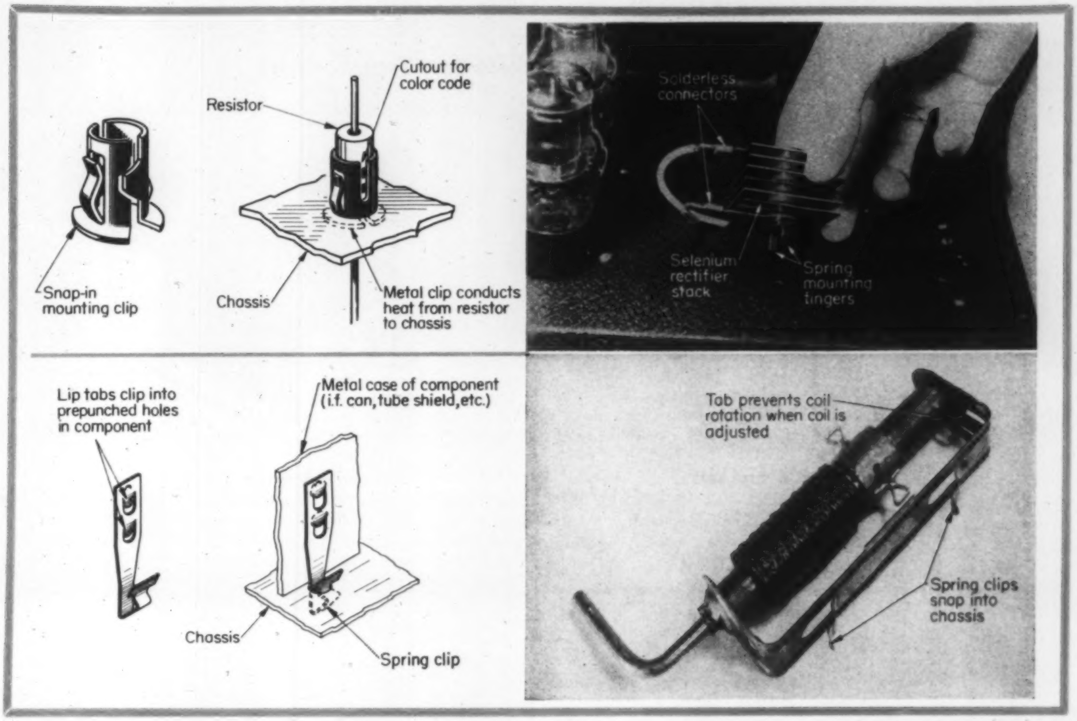

Cutout for color code
Resistor
Snap-in mounting clip
Chassis
Metal clip conducts heat from resistor to chassis
Solderless connectors
Selenium rectifier stack
Spring mounting fingers
Lip tabs clip into prepunched holes in component
Metal case of component (i.f. can, tube shield, etc.)
Chassis
Spring clip
Tab prevents coil rotation when coil is adjusted
Spring clips snap into chassis

Fig. 1—Snap-in clips for mounting electronic components. These mounting devices cut design costs, reduce assembly time, and make component replacement easy. (Illustrations, courtesy Tinnerman Products Inc.)

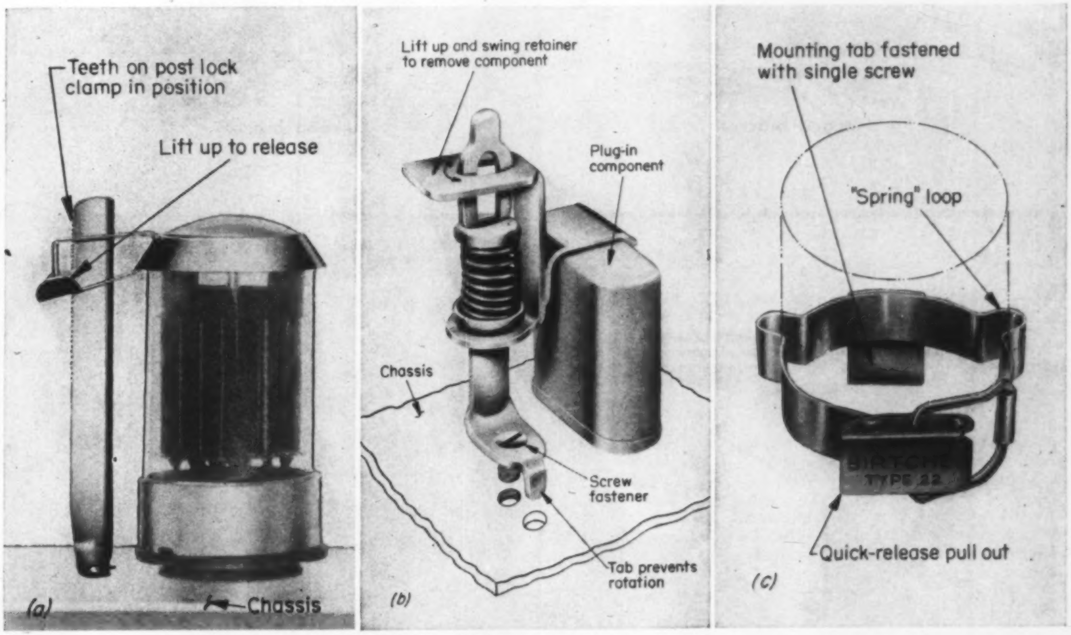
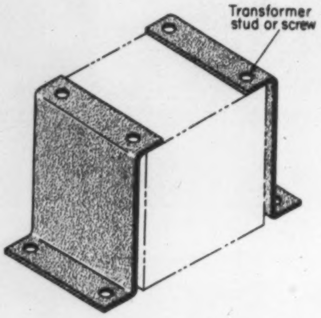
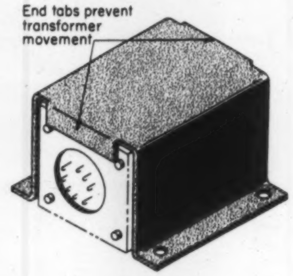

Teeth on post lock clamp in position
Lift up to release
Chassis
(a)
Lift up and swing retainer to remove component
Plug-in component
Chassis
Screw fastener
Tab prevents rotation
(b)
Mounting tab fastened with single screw
"Spring" loop
BIRTCHER TYPE 22
Quick-release pull out
(c)

Fig. 2—Quick-release clamps designed for plug-in components. Tube clamp retainer, *a*, reduces cantilever effect of tube. Clamp for small plug-in units, *b*, has spring-loaded retaining flange which swings to the side for removal of component. Spring loops give positive clamping action in quick-release base clamp for tubes, *c*. (Photos, courtesy Birtcher Corp.)

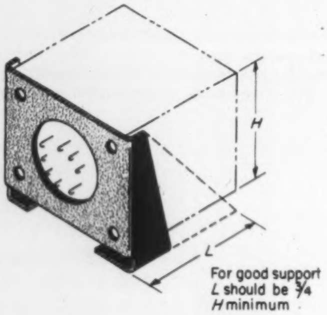
Table 2—Mounting Brackets for Transformers


Transformer stud or screw

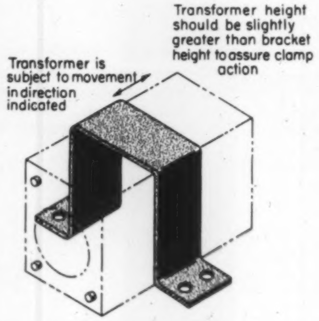
Two-piece Z brackets


End tabs prevent transformer movement

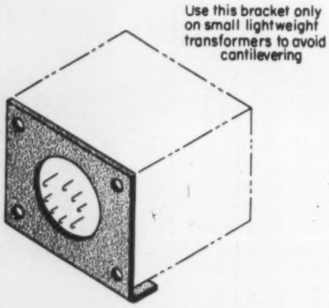
Tabbed enclosure bracket


H
L
For good support L should be ¾ H minimum

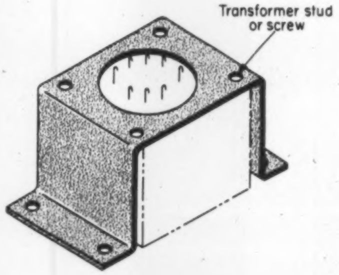
Flanged bracket


Transformer height should be slightly greater than bracket height to assure clamp action
Transformer is subject to movement in direction indicated

U-strap bracket


Use this bracket only on small lightweight transformers to avoid cantilevering

L bracket


Transformer stud or screw

One-piece bracket strap

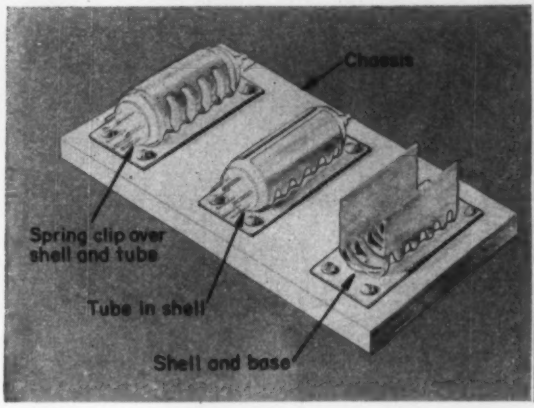

Chassis
Spring clip over shell and tube
Tube in shell
Shell and base

Fig. 3—Wrap-around combination shield-and-tube retainer also forms good heat dissipator. (Photo, courtesy International Electronic Research Corp.)

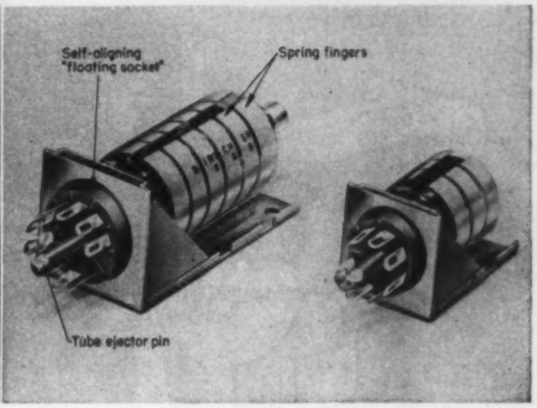
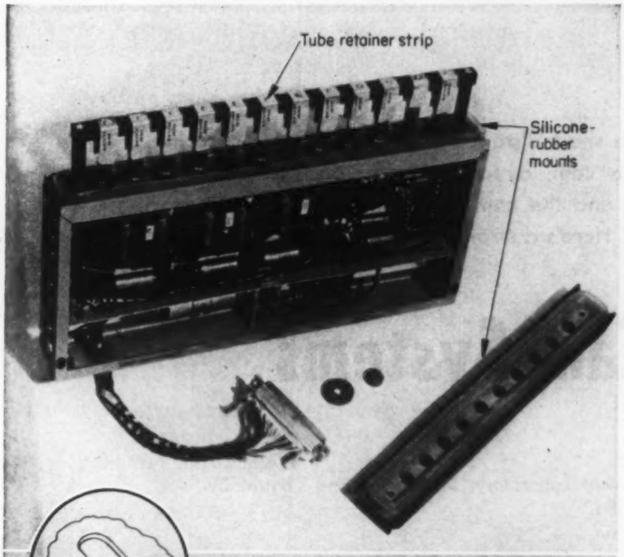
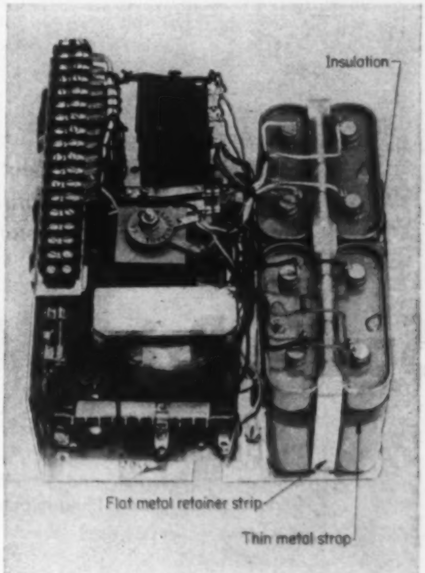

Self-aligning "floating socket"
Spring fingers
Tube ejector pin

Fig. 4—Spring-clamp retainers for miniature electronic tubes. Ejector pins in self-aligning sockets make it easy to remove tubes, particularly in cramped quarters. (Photo, courtesy Birtcher Corp.)


Tube retainer strip
Silicone-rubber mounts


Insulation
Flat metal retainer strip
Thin metal strap

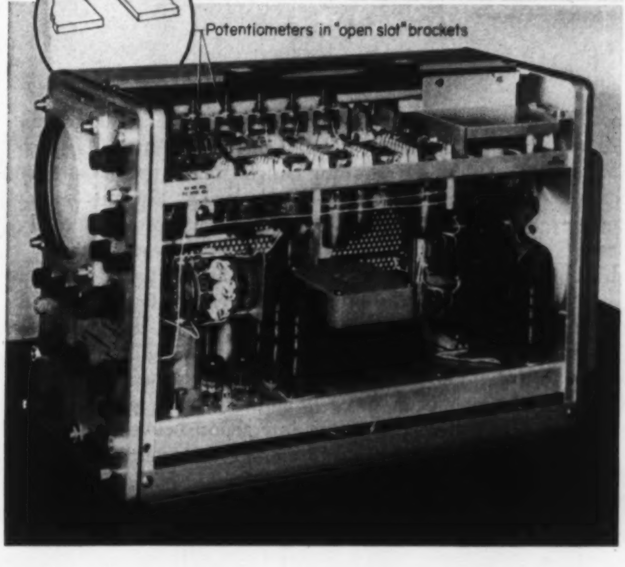

Potentiometers in "open slot" brackets

Fig. 5, Upper left—Custom-built tube retainer strip with shock-and-heat-resistant mounting in unit designed by Emerson Electric Co. Silicone rubber retains its resilience over equipment operating range of −65 to 350 F. (Photo, courtesy Dow Corning Corp.)

Fig. 6, Upper right—Flat metal strip holds four oil-filled capacitors in place. Before mounting, the four capacitors are tied together securely with a thin metal strap fastened with a strapping tool. (Photo courtesy General Electric Co.)

Fig. 7, Left—Open-slot brackets cut in the chassis of this oscilloscope make installation and removal of potentiometers easy and rapid. (Photo, courtesy Tektronix Inc.)

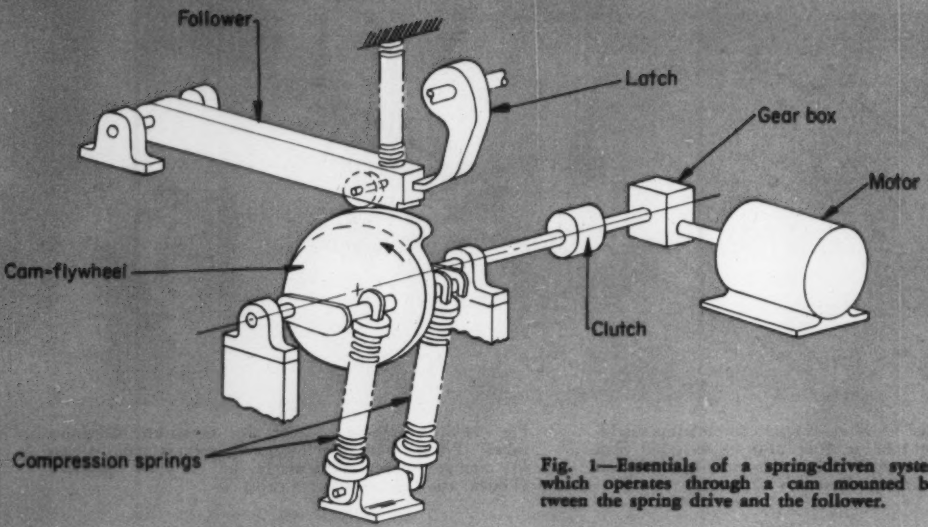


Fig. 1—Essentials of a spring-driven system which operates through a cam mounted between the spring drive and the follower.

Accelerating a mass for a short distance is an easy job for a spring. If the spring drives through a cam, dynamic performance can be controlled. Designing the spring and the cam is complicated by one factor: The cam speed is not constant. Here's a straight-forward way to design . . .

Spring-Driven Cam Systems

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FOR movement at high accelerations or of heavy loads, but at low frequencies, a spring drive minimizes power input required. For example, a small motor, suitably geared, may be used to charge a spring. When the spring is fully compressed, a clutch disengages the motor. Spring energy, released by a starting latch, can drive a heavily loaded follower to its closed position.

This system is simple and reliable but control of dynamic characteristics is severely limited. There are no designed-in features to control elapsed time of operation or follower velocity throughout follower stroke. The system cannot pause in mid-operation, then proceed to the closed position.

More control is achieved when a cam is interposed between the spring drive and the follower, Fig. 1. The spring is directly coupled to a cam which drives the follower system. A motor drive recharges the spring by slowly rotating the cam to its initial position. An overrunning clutch isolates the motor from the cam during high-speed closing. Surplus energy not used in driving the follower is returned to the spring as the cam rotates past top dead center.

By proper design of both the inertia of the cam system and the profile of the cam a large degree of control of the dynamic behavior of the system is available to the designer. Cam design under such conditions is different from other methods of cam design. Cam speed is neither known nor constant. Also, there is a strong interaction between the driving system and the driven or follower system.

The Problem: Known factors are force required by the follower system, expressed as a function of follower displacement or follower velocity, and both inertia and friction in the follower system.

Required is a spring-driven, cam-actuated operating mechanism which must satisfy certain behavior specifications, such as elapsed time for a cycle, follower velocities, and limits of acceleration or deceleration.

The design procedure is detailed in the following sections.

Follower Motion: The first step is to develop displacement-time and velocity-time curves for the desired cycle.

Normally, only a few restrictions are imposed by the desired specifications and these, coupled with dynamic restrictions, define a desired motion. This task can be handled by determining a polynomial expression[1] or by numerical procedures.[2]

Energy Functions: It is assumed that all of the energy input, except the kinetic energy in the rotating cam and its drive, can be defined solely in terms of the follower motion, its derivatives, and time. Energy requirements can then be divided into terms corresponding to:

1. External work which can be defined as a function of follower travel x.
2. Losses which are functions of follower velocity dx/dt. For example, if the follower is immersed in a dense fluid, such as oil, the drag force term is $C_0(dx/dt)^2$.
3. Frictional losses which are proportional to the total loading of the follower linkage.
4. External forces which are initially known only as functions of time. These forces can readily be transcribed into functions of follower position once the desired follower travel has been defined by means of cross plotting.

Linkage friction should be estimated. For intermittent motion devices, linkage friction can be assumed proportional to the load applied, that is, $f = \mu F$.

Torque required to drive the follower is

$$T_f = (1 + \mu_f) \left[F(x) + I_f \left(\frac{dx^2}{d^2 t} \right) + C_D \left(\frac{dx}{dt} \right)^2 + J(t) \right] \quad (1)$$

For a specified motion, all of these terms are functions of follower position. Then, energy requirement E can be calculated. Thus, in Equation 1, let $P(x) = F(x) + J(t)$, where $J(t)$ is transcribed to a function of x by cross plotting. Integration of Equation 1 then gives

$$E_f = (1 + \mu_f) \left[\int_0^x P(x) dx + \int_0^x C_D \left(\frac{dx}{dt} \right)^2 dx + I_f \left(\frac{1}{2} \right) \left(\frac{dx}{dt} \right)^2 \right] \quad (2)$$

Follower energy requirements, therefore, can be determined from Equation 2 as a function of follower position by graphical or numerical integration. Since follower position is known as a function of time a cross plot is readily obtained so that E_f may be tabulated at fixed increments of time.

Spring Characteristics: Total energy which must be supplied to the system can be estimated from the plot of E_f. For a spring drive, energy output of the spring must at all times exceed the follower system requirements. Any excess input energy from the spring at any instant will be stored as kinetic energy in the cam acting as a flywheel.

From an estimate of spring-energy requirements, a tentative spring design can be made. The spring selected will be automatically checked for compatibility with the specified performance by the calculations of the cam profile.

Spring energy requirements are computed on the basis of maximum energy requirements. The spring must offset losses produced by friction in pivot points, by strain energy in the follower system and the driving mechanism, and by terminal kinetic energy stored in moving parts. Thus maximum energy requirements can be estimated from

$$(E_s)_{max} > (1 + \mu_s)(E_f)_{max} \quad (3)$$

where $(E_f)_{max}$ is determined from Equation 2 at the end of the follower stroke. Gradient and initial compression of the spring will be dictated by stress and space considerations and the energy requirement.

Spring Energy vs. Cam Position: Input energy E_s

Nomenclature

C_D = Drag coefficient for members moving in dense fluids
E_f = Total follower energy requirements
E_s = Input or driving spring energy
F_x = Torque (position-dependent component)
F_0 = Initial force exerted by compression spring
I_f = Moment of inertia of follower system
I_s = Moment of inertia of cam-spring system
i = Increment number
J = Torque (time-dependent component)
k = Spring gradient
P = Torque (combined position and time-dependent terms)
R = Initial torque of driving spring in charged position
T = Torque
T_f = Torque required to drive follower
t = Time
W_f = Follower work, normal operation
W_f' = Additional follower work under short-circuit conditions
x = Follower travel
y = Spring displacement from charged position
θ = Cam rotation
θ_0 = Initial cam rotation to take up clearance between cam follower and cam surface
μ = Load-proportional friction coefficient
μ_f = Coefficient of friction of follower system
μ_s = Friction coefficient, spring-cam unit

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[1] References are tabulated at end of article.

Table 1—Initial Data for Follower System

1 Time t (sec)	2 Lift x (rad)	3 Velocity dx/dt (rad/sec)	4 Normal Work, W_f (in-lb)	5 Kinetic Energy* (in-lb)	6 Gross Energy Input, E_f† (in-lb)
0.010	0.059	11.8	70	630	876
0.020	0.197	15.8	310	1120	1790
0.030	0.355	15.9	1000	1140	2680
0.040	0.501	13.4	1800	810	3260
0.050	0.615	9.4	2600	400	3760
0.055	0.657	7.1	3000	230	4040

Other initial data: $W_f' = 3000$ in-lb, $I_f = 9$ lb-in-sec^2, $\theta = 180$ deg $= 3.14$ rad, $\theta_0 = 0.7$ rad, $\mu_f = 1/3$, $\mu_8 = 1/4$.

*Kinetic energy $= \frac{1}{2} I_f(dx/dt)^2$.

†$E_f = (1 + \mu_f)[(\text{Col. } 4) + (\text{Col. } 5)]$.

1 Increment Number i	2 Time t (sec)	3 Gross Energy Input, $(E_f)_i$ (in-lb)	4 Displacement θ_i (rad)
		From Table 1	
0	0	0	0.700
1	0.005	450	0.869
2	0.010	876	1.042
Calculation procedure repeated to end of problem, $t = 0.055$ sec			
11	0.055	4040	3.71

can be tabulated for various positions θ of the cam. The manner in which cam rotation and energy input are related depends on the design. Thus, if a torsion spring is directly coupled to the cam, spring energy E_s supplied to the system is

$$E_s = R\theta - \frac{k}{2}\theta^2 \tag{4}$$

The derivative is

$$\frac{dE_s}{d\theta} = R - k\theta \tag{5}$$

A torsion spring mechanism is shown in Fig. 2.

If a helical compression or tension spring is used to drive a cam through a half revolution by means of a crank, the kinematic relationship between spring length and cam rotation must be determined. If the change in spring length from its fully compressed length at cam dead center is designated y, the spring energy supplied to the system at any point is

$$E_s = F_0 y - \frac{k}{2}y^2 \tag{6}$$

When y has been determined as a function of crank angle θ, E_s is related to θ for the complete spring stroke. Derivative $dE_s/d\theta$ is then determined by graphical differentiation of a plot of E_s versus θ.

Inertia of Cam-Spring System: Moment of inertia I_s of the cam-spring system serves as a flywheel to store energy given up by the spring and to transfer this energy into the follower system when required. Its magnitude is ultimately selected by requiring that the cam go through the required angle of rotation in the same time specified for the follower stroke. At this point in the calculations, the magnitude of I_s must be assumed. Subsequent calculations will indicate how this assumed value should be modified.

Cam Velocity and Displacement: Broadly speaking, all the information has now been compiled into two sets of data:

1. Follower system energy requirement E_f as $f(t)$.
2. Cam driving-system energy input E_s and its derivative $dE_s/d\theta$ as functions of cam displacement θ.

Calculations must determine whether these energy data for cam and follower are compatible with the assumed I_s of the cam driving system. Use the following equations to calculate, increment by increment, cam rotational velocity and displacement as functions of time:

$$\frac{d\theta}{dt} = \left[\frac{2}{I_s}\left(\frac{E_s}{1+\mu_s} - E_f\right)\right]^{1/2} \tag{7}$$

$$\theta = \int \frac{d\theta}{dt}\,dt \tag{8}$$

These nonlinear equations cannot be solved in closed form since E_s is known only as a function of θ, and E_f is known only as a function of time. Hence numerical methods are required.

One possible solution is not the most accurate but has the virtue of simplicity. It employs Equations 9 and 10:

$$\left(\frac{d\theta}{dt}\right)_{i+1} \approx \left\{\frac{2}{I_s}\left[\frac{(E_s)_i}{1+\mu_8} + \frac{1}{1+\mu_8}\left(\frac{dE_s}{d\theta}\right)_i\left(\frac{d\theta}{dt}\right)_i \Delta t - (E_f)_{i+1}\right]\right\}^{1/2} \tag{9}$$

$$\theta_{i+1} \approx \theta_i + \frac{\Delta t}{2}\left[\left(\frac{d\theta}{dt}\right)_i + \left(\frac{d\theta}{dt}\right)_{i+1}\right] \tag{10}$$

Here i identifies conditions existing at the beginning of the i-th increment of time, and $i + 1$ identifies conditions prevailing at the beginning of the next increment of time.

Determining Cam Profile: From Equation 8 or 10, data have been obtained on cam rotation θ versus time. At the start of the problem, data on follower lift x vs. time were compiled. Since both θ and x are known as functions of time, they provide data on

Table 2—Calculation of Cam Rotation as a Function of Time
First Trial—Assumed value $I_e = 1.6$ lb-in-sec²

5 Velocity $(d\theta/dt)_i$ (rad per sec)	6 Input Energy, $(E_S)_i$ (in-lb)	7 Torque $(dE_s/d\theta)_i$ (in-lb)	8 Energy Increment ΔE, (in-lb)	9 Term in Equation 9 (in-lb)	10 Energy $(E_f)_{i+1}$ (in-lb)	11 Terms in Equation 9 (in-lb)	12 Velocity $(d\theta/dt)_{i+1}$ (rad per sec)	13 Rotation θ_{i+1} (rad per sec)
	From Fig. 4	From Fig. 4	(7) (5) (Δt)	$\frac{(6) + (8)}{1 + \mu_s}$		(9) − (10)	$[(2/I_e)(11)]^{1/2}$	$4 + \frac{1}{2}(5 + 12)(\Delta t)$
34.0	1230	3380	570	1350	450	900	33.6	0.869
33.6	1850	3900	655	1880	876	1004	35.5	1.042
35.5	2615	4550	805	2570	1340	1230	39.2	1.865
63.3								

follower lift vs. cam rotation from which the cam profile can then be laid out.

Example: This design approach has proven valuable in the design of closing mechanisms for circuit breakers. Normally, a circuit breaker is required to close in a specified time, against a load composed of spring forces and friction. Also, strict limits are imposed on the velocity of the closing motion at two positions: 1. Where the contacts initially touch. 2. at the end of the stroke.

An additional requirement is that sufficient energy must be available to close the circuit breaker under short circuit conditions during which electromagnetic repulsion forces become very large.

Schematically, the system under consideration can be represented by Fig. 1. Table 1 and Fig. 3 define characteristics of the system known at the start of the problem.

Work done by the follower (contact) in closing against normal opposing forces is compiled in Column 4, Table 1. Given the moment of inertia of

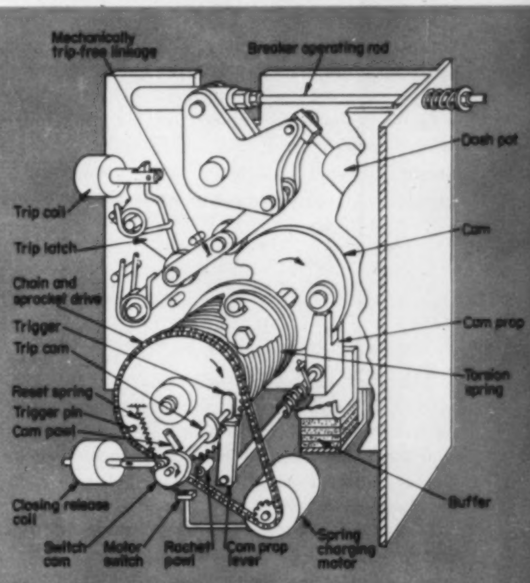
Mechanically trip-free linkage
Breaker operating rod
Dash pot
Trip coil
Trip latch
Cam
Chain and sprocket drive
Trigger
Trip cam
Cam prop
Torsion spring
Reset spring
Trigger pin
Cam pawl
Buffer
Closing release coil
Switch cam
Motor switch
Rachet pawl
Cam prop lever
Spring charging motor

Fig. 2—Torsion-spring-driven mechanism in a distribution circuit breaker.

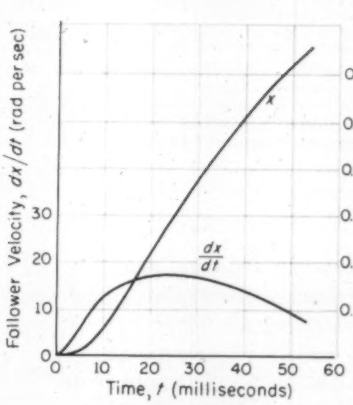

Fig. 3—Follower displacement and velocity specified as objectives.

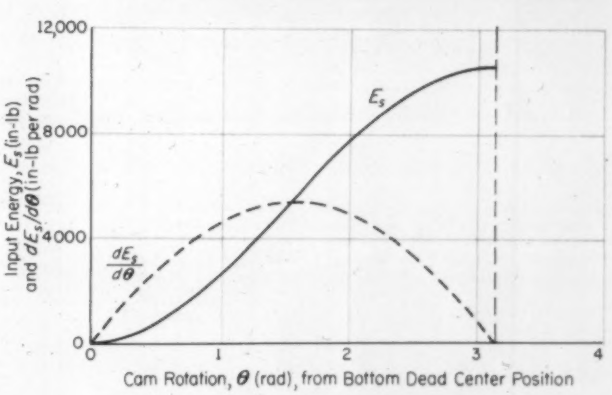

Fig. 4—Input spring energy and torque modified for the kinematics of the mechanism shown in Fig. 2.

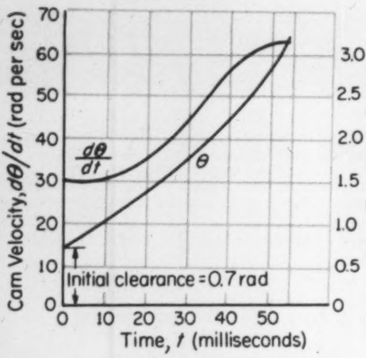

Fig. 5—Calculated cam displacement and velocity with correct cam moment of inertia.

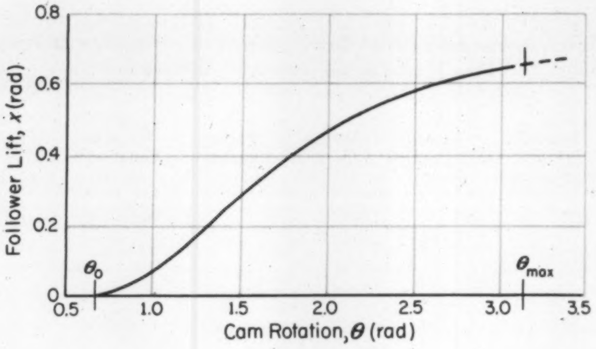

Fig. 6—Plot of calculated data for generation of a cam profile.

the follower system, the follower kinetic energy, $\frac{1}{2}I_f\ (dx/dt)^2$, is computed in Column 5 for given values of follower velocity, Column 2. Required input energy under normal conditions, including friction, is tabulated in Column 6.

Consider next the maximum energy requirements of the spring which will operate the closing mechanism. From Equation 3 and data in Table 1, minimum energy supplied to the system must be

$$E_s > (1 + \mu_s)\left[(E_f)_{max} + (1 + \mu_f)W_f'\right]$$

$$E_s > \frac{5}{4}\left[\ 4040 + \frac{4}{3}\ (3000)\ \right]$$

$$E_s > 10{,}000 \text{ in-lb}$$

Therefore, a set of springs is selected to provide 10,500 in.-lb to perform the closing operation under the most adverse conditions. The problem is to design a system which will have tolerable dynamic behavior under normal follower operation even with this large excess of energy.

Next, a kinematic layout is made to determine spring length vs. cam rotation angle θ. From this relationship, plus spring gradient and spring initial force, the operating spring energy E_s is calculated and plotted vs. θ. In addition, values of $dE_s/d\theta$ are also calculated and plotted, Fig. 4.

The data of Table 1 and Fig. 4 are adequate for solving the primary problems, namely, determination of the correct magnitude of the inertia of the cam-spring mechanism and the required cam profile, x vs. θ.

An initial estimate of cam mechanism inertia I_θ is made. From Equations 9 and 10, cam displacement is determined as a function of time. For this problem, a sample long-hand computation is shown in Table 2. Note that in Table 2, the time required to take up clearance between the cam and follower is not included in the computation. Time zero is the instant at which clearance is just taken up. At this time, the cam has rotated through 0.7 radian.

With the initially assumed value I_θ = 1.6 lb-in.-sec^2, Table 2, the cam rotates through 3.7 radians in the required time of 0.055 sec. Since the cam is required to rotate through only 3.14 radians in this time, it is evident that the original estimate of I_θ is too small.

As a second guess, a value of I_θ = 2.1 lb-in.-sec^2 is selected and the computations repeated. Plotting the results for the two computations and interpolating show that the correct value for I_θ is about 1.97 lb-in.-sec^2. By repeating the calculations with this value of I_θ, correct values of θ and $d\theta/dt$ are computed. The results are plotted in Fig. 5.

Since values of x are already known as a function of time, Fig. 3 and Table 1, data on x vs. θ, required to generate the cam profile, are available. Table 3 and Fig. 6 summarize the results.

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ACKNOWLEDGMENT

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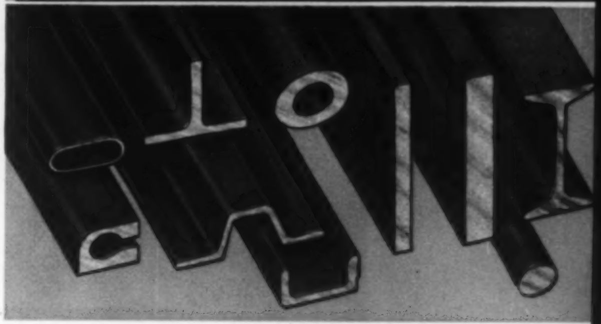
Table 3—Data for Generation of Cam Profile

Follower Lift x (rad)	Cam Rotation θ (rad)	Cam Velocity $d\theta/dt$ (rad/sec)	Follower Velocity dx/dt (rad/sec)	Displacement Ratio $dx/d\theta$ (rad/rad)
0	0.7	30.59	0	0
0.059	1.005	31.02	11.8	0.38
0.197	1.333	35.35	15.8	0.445
0.355	1.724	43.56	15.9	0.364
0.501	2.222	55.46	13.4	0.242
0.615	2.819	62.76	9.45	0.151
0.657	3.13	62.38	7.15	0.115

Conference Transactions

Transactions of the Fifth Conference on Mechanisms (239 pages), containing the 19 papers presented, are available at $3.00 each from Reader Service Dept., MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.



Designing Magnesium Extrusions

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MAGNESIUM extrusions are structurally efficient and economical to use in lightweight products. Compared to other fabricating methods, extrusion offers increased design freedom and lower production costs. Sections cut from an extruded shape can often replace parts that must be individually cast, forged, or machined. Also, it is possible for a single extrusion to replace a section fabricated from several parts, thus eliminating joining and machining operations. Increased strength of the part, close tolerances, and improved appearance are additional benefits realized from the process.

With eight magnesium alloys to choose from, the designer has a wide range of properties available for serviceable parts for room-temperature or high-temperature applications. Depending on the alloy, tensile strength of extruded shapes ranges from 37,000 to 55,000 psi. Pellet extrusions, noted for their exceptionally high compressive yield strength, are also available.

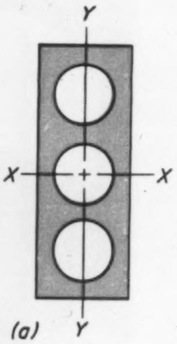
Cost and Quantity: Since extrusion dies are relatively inexpensive (typical cost: $125 to $200), mag-

Practical Extrusion Shapes and Sizes

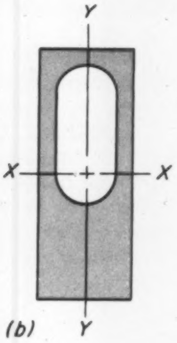
The most important consideration in extrusion design is symmetry of the section. Extrudability of sections such as *a* is excellent because the shape is symmetrical about axes X-X and *Y-Y*. Here, no difficulty would be experienced in maintaining standard tolerances on any dimension. The shape at *b*, although not symmetrical about *X-X*, has a fairly uniform wall thickness surrounding the void. This permits good flow conditions during extrusion, and the shape would cause little or no difficulty in meeting standard tolerances.

Generally, hollow shapes are most readily produced when wall thicknesses around voids are uniform or nearly so. An undesirable design, *c*, is symmetrical about *Y-Y* but not about *X-X*. The large mass of metal below the void greatly affects flow conditions during extrusion. It is difficult to maintain location of the hole within standard tolerances.

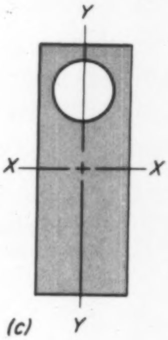
Design of a common type of flooring section, *d*, shows good extrudability. Die tongues are symmetrical about the root



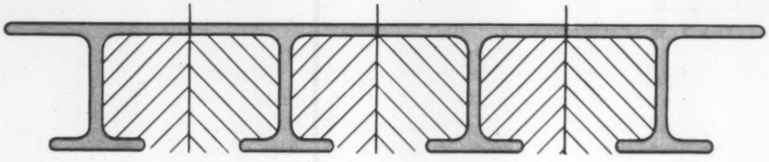
(a)



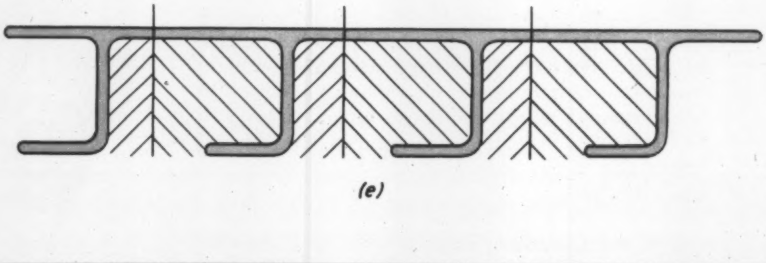
(b)



(c)



(d)



(e)

centerline as shown by the shaded areas. Some difficulty will be experienced in extruding *e* if it is necessary to maintain normal angularity tolerances on the stiffeners in relation to the skin. This is because the stiffeners are not symmetrical about the root centerlines. Eccentric loads imposed by this condition during extrusion increase tongue deflection and, in extreme cases, may cause premature tool failure.

One of the most difficult shapes to extrude is the wedge, *f*. Although symmetrical about the centerline, the section is greatly unbalanced. Flow control during extrusion is difficult because the metal flows more readily through the large base than through the knife edge. As a result, over-all width variations are considerable. Also, sections coming off the press are not straight, which creates the problem of finishing to standard straightness tolerances. To make extreme wedges feasible, it is sometimes necessary to add metal to the knife edge, *g*. This improves extrudability and prevents edge damage.

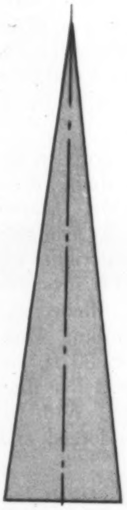
Thin hollow shapes, *h* and *j*, are difficult to extrude to standard flatness and/or curved-surface tolerances. Such sections can often be improved by adding one or more stiffener ribs as shown by the dashed lines. This method is used primarily for sections in which width is roughly three or more times the height and when maximum section height is 2 in. or less. If addition of stiffeners is not possible, an increase in wall thickness may be required to minimize flatness or contour difficulties.

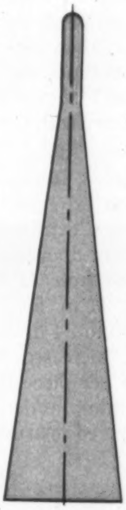
A practical extrusion design permits uniform metal flow, *k*. With the slot centered, section thickness is uniform, and tolerances and tool life can be maintained readily. Unequal wall thickness on either side of a slot, *l*, impairs tool life and tolerances because of unequal flow conditions during extrusion.

A typical semihollow shape, *m*, must usually be produced by the same methods used for hollow shapes. It is impossible to support the die tongue (on a flat die) sufficiently to prevent breakage. Because of the similarity of production methods, semihollow and hollow shapes cost about the same.

The long, thin leg projecting from the heavy mass, *n*, represents a design which is difficult to extrude. Again, because of the unequal flow conditions during extrusion, it is difficult to maintain standard tolerances on the leg and standard straightness on the finished length. It may be necessary to increase tolerances or revise the section design.

In designs where a web is thinner than the flanges, *o*, it is difficult to produce standard flatness and angularity tolerances in the part. Extrudability is much improved by increasing web thickness and adding generous fillets at the junctions of the web and flanges as shown by the dashed lines.


(f)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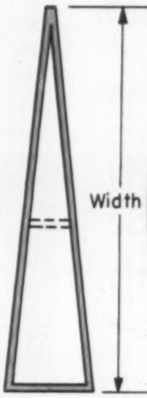

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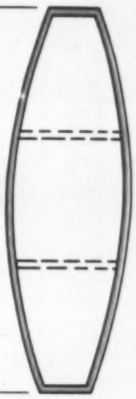
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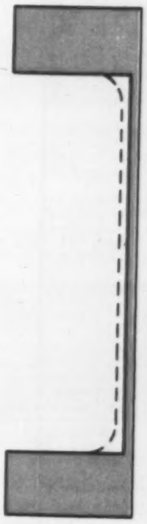
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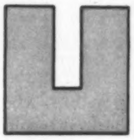
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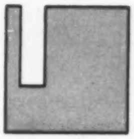
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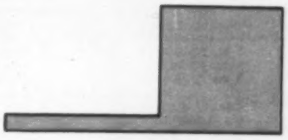

(n)

nesium extrusions are economical even when small production runs are required. The relative cost of magnesium and aluminum extrusions varies with alloys used. Realistic price comparisons must be made on a volume basis rather than on a per-pound basis because of the different densities. On a volume basis, magnesium extrusions cost approximately the same as aluminum extrusions of comparable strength.

Cost of extruded metal is only one factor in total product cost. In virtually all cases, a raw extrusion requires machining of some kind prior to use. Magnesium's excellent machinability often significantly reduces over-all manufacturing costs. Cutting speeds to 9000 fpm are a reality in finish-milling operations which produce mirror finishes. Stock feed can be as high as 120 ipm.

Table 1—Minimum Wall-Thickness for Extruded Round Tubing

(All dimensions in inches)

	Magnesium Alloy				
Specified OD	AZ31B AZ31C	AZ61A	M1A	ZK60A	Minimum ID
0.25 to 0.99	0.028	0.028	0.028	0.028	*
1.00 to 1.99	0.045	0.080	0.040	0.050	*
2.00 to 2.99	0.062	0.120	0.050	0.080	0.125
3.00 to 3.99	0.062	0.156	0.050	0.109	0.500
4.00 to 4.99	0.062	0.156	0.062	0.109	½ OD
5.00 to 5.99	0.078	0.188	0.062	0.125	
6.00 to 6.99	0.094	0.219	0.078	0.156	
7.00 to 7.99	0.125	0.250	0.094	0.188	
8.00 to 8.99	0.156	0.281	0.125	0.219	
9.00 to 9.99	0.188	0.312	0.156	0.250	
10.00 to 13.99	0.280	0.438	0.219	0.350	
14.00 to 15.99	0.320	0.500	0.250	0.400	
16.00 to 17.99	0.360	0.563	0.281	0.450	
18.00 to 19.99	0.400	0.625	0.312	0.500	
20.00 to 21.99	0.440	0.688	0.344	0.550	
22.00 to 23.99	0.480	0.750	0.375	0.600	

*Subject to special inquiry of extruder.

Table 2—Minimum Section Thickness for Extrusions*

(All dimensions in inches)

	Magnesium Alloy			
Circumscribing Circle Diam	AZ31B AZ31C	AZ61A AZ80A	M1A	ZK60A
0.50 to 0.99	0.040	0.040	0.035	0.040
1.00 to 1.99	0.045	0.045	0.040	0.045
2.00 to 2.99	0.050	0.050	0.045	0.050
3.00 to 3.99	0.050	0.062	0.050	0.062
4.00 to 4.99	0.062	0.078	0.062	0.078
5.00 to 5.99	0.078	0.094	0.062	0.085
6.00 to 6.99	0.094	0.109	0.078	0.100
7.00 to 7.99	0.109	0.125	0.094	0.125
8.00 to 9.99	0.125	0.188	0.109	0.150
10.00 to 12.99†	0.115	0.140	0.100	0.125
13.00 to 15.99†	0.125	0.156	0.110	0.140
16.00 to 18.99†	0.146	0.178	0.130	0.165
19.00 to 22.99†	0.160	0.190	0.140	0.178
23.00 and over†	Subject to special inquiry of extruder.			

*Rod, bar, solid, and semihollow shapes.
†Covers extrusions produced from 13,200-ton press.

Surface Treatment: In all except highly saline atmospheres, a simple chrome-pickle treatment usually provides adequate protection for extruded surfaces. In normal inland temperatures, magnesium develops a characteristic thin gray film that retards further oxidation. For applications in severe environments, a variety of chemical and anodic treatments are available for magnesium. The metal can also be readily painted with satisfactory results.

Section Limits and Extrusion Sizes: Minimum section thicknesses for magnesium extrusions are 0.028 in. for round tubing and 0.035 in. for rod, bar, and solid and semihollow shapes. Permissible minimum thickness is influenced by the diameter of the circumscribing circle or the specified OD, Tables 1 and 2. Values shown are for typical extrusions approximately 40 ft long.

Maximum length of an extrusion depends on the cross-sectional area of the shape, size of the billet, and tolerances required. The more symmetrical the shape the thinner its section can be. For stepped extrusions, the ratio of areas of the major and minor sections should not exceed 5 to 1.

Magnesium extrusions can be produced in widths to 28 in. if extruded in their finished shape. Extra-wide sections can be produced by extruding V, U, or O shapes which are then flattened. Width of the section can be to 1.6 times the diameter of the billet container with the V form, to 1.8 times with the U form, and to 2.2 times with the O form.

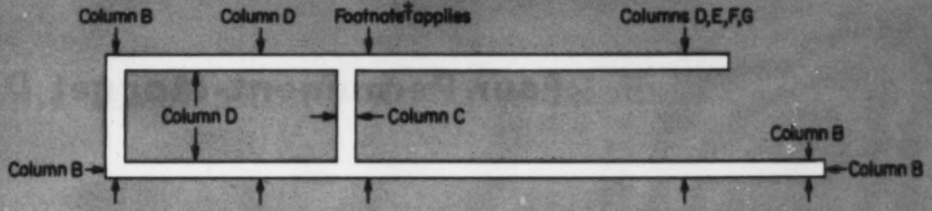
With the addition of a 13,200-ton press to the magnesium industry's facilities, design limits of extrusions have been extended considerably. Larger, longer, and thinner extrusions are now available, Table 3. Maximum diameter of circumscribing circles have increased from 11 to 28 in. for structural shapes, from 9 to 24 in. for integrally stiffened sections, and from 10 to 24 in. for round tubing. Maximum length has increased from 45 to 80 ft, and maximum weight per piece has increased five times for a given minimum section thickness. With this press, hollow tapered extrusions with forged ends

Table 3—Mechanical Properties of Magnesium Extrusions*

Alloy and Temper (bars, rods, shapes)	Size Classification	Ultimate Tensile Strength (psi)	Tensile Yield Strength (psi)	Elongation (per cent)	Compressive Yield Strength (psi)
ZK60A—F	5 to 50 in.^2	43,000	31,000	4	20,000
ZK60A—T5	5 to 10 in.^2	45,000	36,000	4	25,000
ZK60B—B†	5 to 20 in.^2	45,000	35,000	4	35,000
AZ31B—F	Least dimension				
	To 0.250 in.	35,000	18,000	8	12,000
	0.250 to 1.499 in.	34,000	20,000	8	12,000
	1.500 to 2.499 in.	34,000	20,000	8	10,000
	2.500 to 5.000 in.	32,000	18,000	8	10,000
HM31XA	(Typical values)	37,000	26,000	4	15,000

*Extrusions from 13,200-ton press only. Values (except for HM31XA) are minimums rather than typicals. Properties of small extrusions are the same or slightly better than those of the heavy-press extrusions. †Pellet extrusions.

Table 4—Extrusion-Section Tolerances
(All dimensions in inches)



Specified Dimension	At points where dimension is at least 75% metal — Except those covered by C	At points where dimension is at least 75% metal — Wall thickness† enclosing space 0.11 in.² or more	At points where dimension is less than 75% metal* — Distance from base of leg (in.)→ 0.250 to 0.624	0.625 to 1.249	1.250 to 2.499	2.50 or more
A	B	C	D	E	F	G
Under 0.125	±0.006	±10% (max 0.060, min 0.010)	±0.010	±0.012	±0.014	±0.016
0.125 to 0.249	0.007		0.012	0.014	0.016	0.020
0.250 to 0.499	0.008		0.014	0.016	0.018	0.022
0.500 to 0.749	0.009		0.016	0.018	0.020	0.026
0.750 to 0.999	0.010		0.018	0.020	0.022	0.030
1.000 to 1.499	0.012		0.020	0.022	0.026	0.034
1.500 to 1.999	0.016		0.024	0.028	0.034	0.050
2.000 to 3.999	0.024		0.032	0.036	0.048	0.064
4.000 to 5.999	0.034		0.042	0.050	0.064	0.088
6.000 to 7.999	0.044		0.054	0.062	0.082	0.112
8.000 to 9.999	0.054		0.064	0.074	0.100	0.136
10.000 to 11.999	0.064		0.074	0.088	0.116	0.160
12.000 to 13.999	0.074		0.084	0.100	0.134	0.184
14.000 to 14.999	0.080		0.090	0.106	0.142	0.196

*Where space is completely enclosed, width tolerance is the value in Column D for a dimension equal to depth, and conversely, but in no case is the tolerance less than at the corners, Column B.

†Where outside and inside dimensions rather than wall thickness are specified, tolerances in Column C apply to mean wall thickness. For Class 1 hollow shapes, standard wall thickness tolerance for round tubing applies.

‡At points less than 0.250 in. from base of leg, tolerances in Column B apply.

can be produced, thus eliminating extensive machining of forgings.

Tolerances and Surface Finish: Closer tolerances can be held on extruded magnesium parts using standard production techniques than can be held on roll-formed parts. Even tighter tolerances can be achieved with special techniques.

Using these special techniques, magnesium extrusions with closer tolerances than those obtained in drawn shapes can be produced. Machining operations normally required to obtain close tolerances for precise-fitting parts can be eliminated. Precision diameter tubing, notches and V forms with sharp inside corners and deep, thin slots also are produced using these techniques. Solid-metal dimensional tolerances are almost always improved. Space dimensions may or may not be improved depending on configuration.

For wide sections extruded in V, U, or O forms prior to flattening, solid-metal dimensional tolerances are the same as those for sections extruded in finished form. Space-dimension tolerances, however, must be from 1.5 to 2.0 times greater. Typical tolerances for sections extruded in finished form are shown in Table 4.

In addition, for curved surfaces on bars, rods, and shapes, allowable deviation from specified contour is 0.005 in. per in. of chord length (minimum tolerance: 0.005 in.). Tolerance is not applicable to more than 90 deg of any arc.

For flat surfaces on bars, rods, and shapes, deviation from flatness does not exceed 0.004 in. per in. of width with a minimum value of 0.004 in. This tolerance is not applicable to surfaces of walls 0.250 in. thick or less that completely enclose a void. End cuts are square within ±1 deg.

For tubing angularity, allowable deviation from the specified angle is ±2 deg. Cut ends are square within ±1 deg. Other tolerances on bars, rods, and shapes, similar to those in Table 4, are available.*

Frequently, a particular tolerance or tolerances may be critical while others are not If this information is made available to the extruder, closer tolerances can usually be held on certain dimensions if wider tolerances are satisfactory on others.

Allowable depth of defects on bars, rods, and shapes varies 0.0015 in. for sections under 0.064 in. thick, to 0.0080 in. for sections 0.501 in. thick and over. Typical defects include die marks and handling and polishing marks.

Magnesium Design, Dow Chemical Co., Midland, Mich., 1957, pp. 198-199.

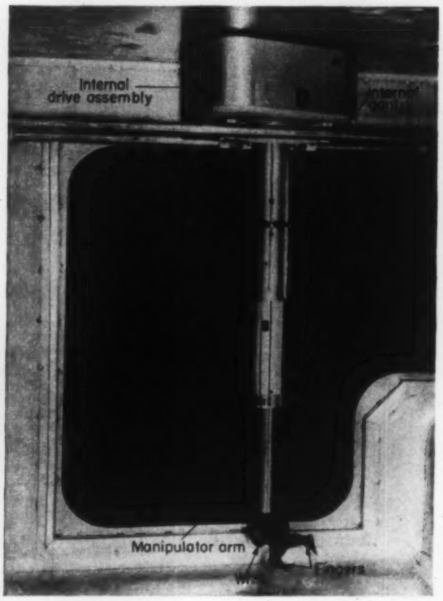
They Say . . .

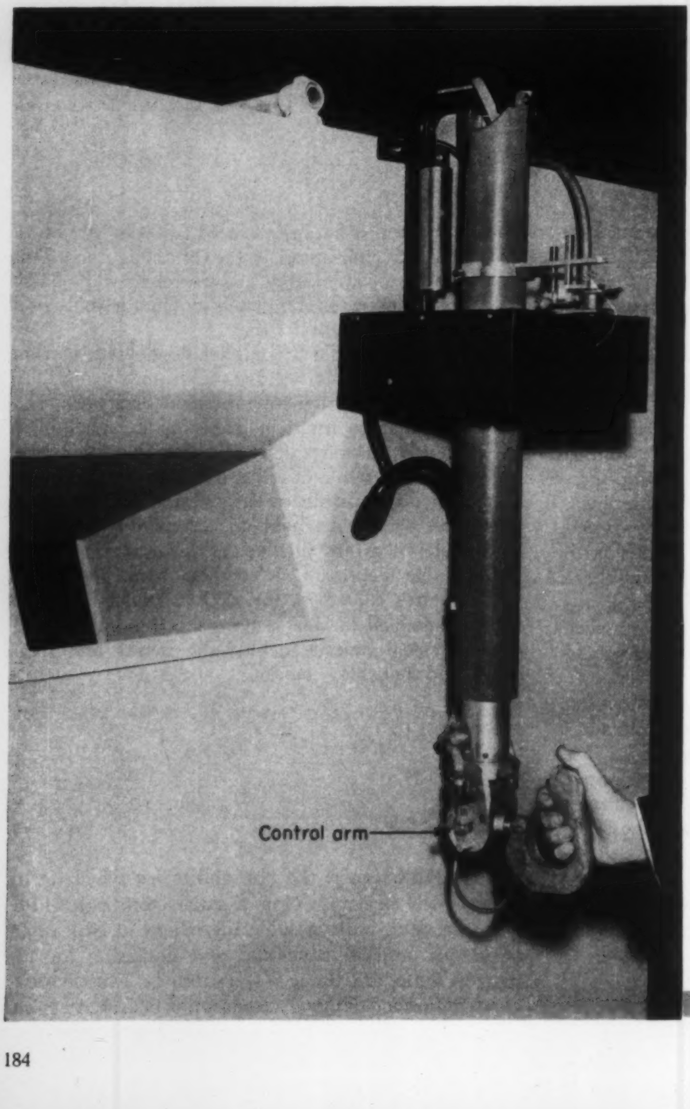
" . . . thinking is the one ability for which technology will never develop a satisfactory substitute. It is the vital, indispensable ingredient in education, in design, and in educating and designing for tomorrow's modern living."—Samuel L. Fahnestock, *chief industrial designer, Aluminum Co. of America.*

Four Permanent-Magnet Drives

TWO MAGNETICALLY COUPLED GANTRIES permit complete isolation of driving from driven members in a French-designed mechanical manipulator. The drive assembly was developed for a manipulator operated inside a sealed stainless-steel cell where alpha, beta, or gamma radiation is present, or highly toxic or pyrophoric materials have to be handled in special atmospheres or a vacuum. The manipulator is also applicable where conventional sealing materials cannot be used because of high temperatures, powerful solvents, etc.

The manipulator is manufactured in France by the Lip Co. under license from the French Atomic Energy Commission.


Internal drive assembly
Internal gantry
Manipulator arm
Wr
Fingers

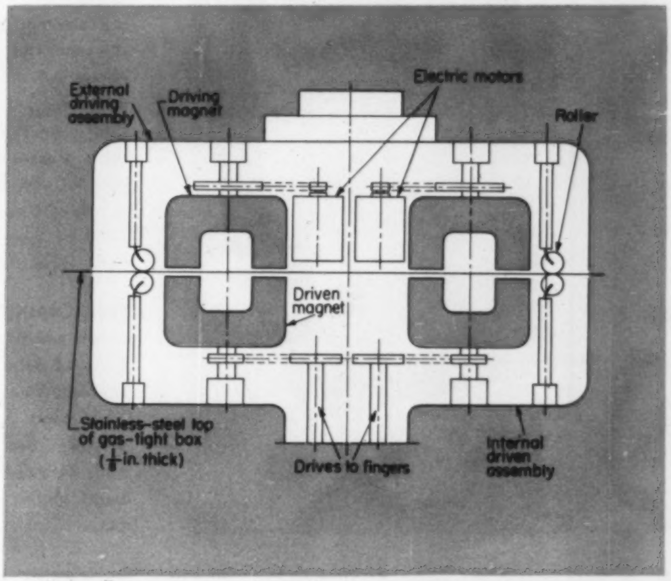

Control arm

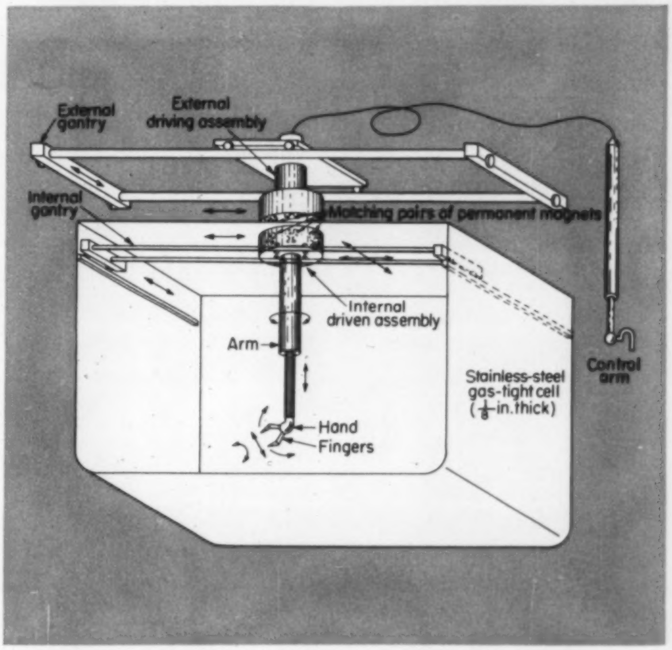
Transmit Seven Manipulator Motions

EXTERNAL DRIVING ASSEMBLY, which is mounted on a gantry above the sealed stainless-steel cell, contains four motor-driven permanent magnets. Directly below, inside the cell, are four matching permanent magnets in the driven assembly, which is also mounted on a gantry. These four pairs of magnets have a gap between them of ¼ to ⅜ in. In this gap is the ⅛-in. thick stainless-steel top of the cell.

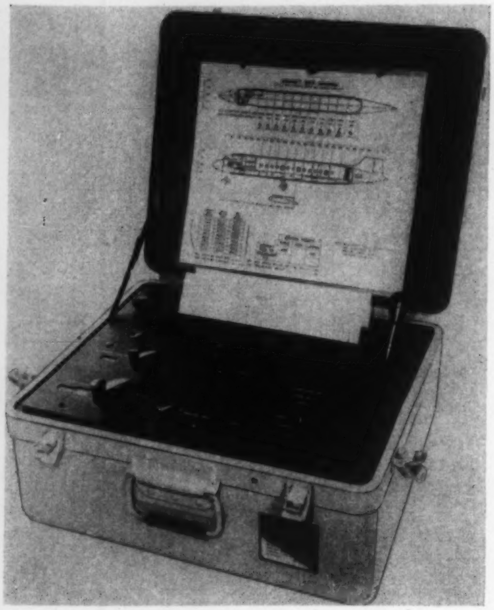
Each matching pair of magnets, or magnetic coupling, can be individually controlled. One of the four couplings raises or lowers the manipulator arm at will. A second coupling rotates the "hand" in a vertical plane through an angle of 145 deg, while the third pair of magnets continuously rotates the hand at the wrist in either direction. The fourth pair clamps or releases the "fingers."

Transverse and longitudinal movements of the electrically powered external gantry are followed exactly by the internal gantry (and the manipulator arm) because of magnetic attraction between all four pairs of magnets. Rotation in a horizontal plane of the complete external drive assembly will rotate the internal driven assembly (and the complete manipulator arm), producing the seventh basic direction of motion required.


External driving assembly
Driving magnet
Electric motors
Roller
Driven magnet
Stainless-steel top of gas-tight box ($\frac{1}{8}$-in. thick)
Drives to fingers
Internal driven assembly

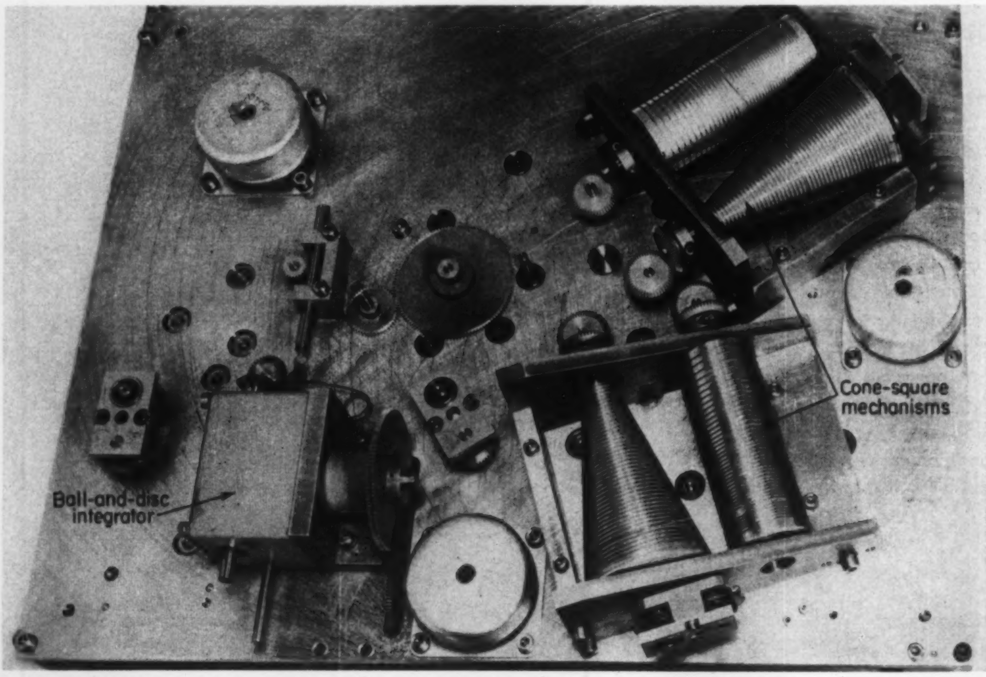

External gantry
External driving assembly
Internal gantry
Matching pairs of permanent magnets
Internal driven assembly
Arm
Hand
Fingers
Stainless-steel gas-tight cell ($\frac{1}{8}$-in. thick)
Control arm

Aircraft All-Mechanical Computer

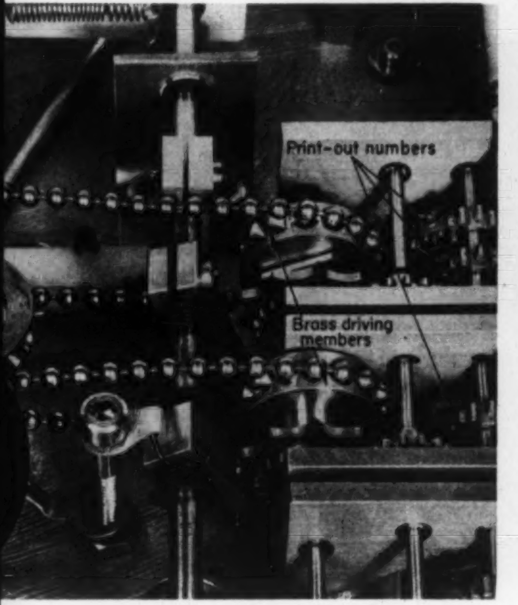


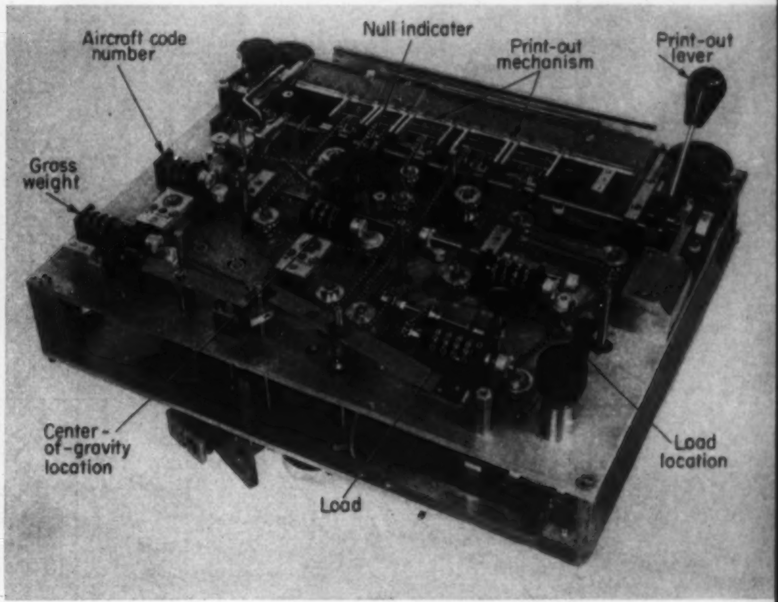
RAPID SOLUTIONS to aircraft weight-and-balance problems (c.g. location) are accomplished in an all-mechanical computer to an accuracy of plus or minus 0.4 in. Designed by David B. Brannen, Librascope Inc., Glendale, Calif., the hand-powered machine accepts gross-weight values from 300 to 600,000 lb over a center-of-gravity range of 0 to 999 in. Final computations of load distribution are printed by a mechanical readout device.

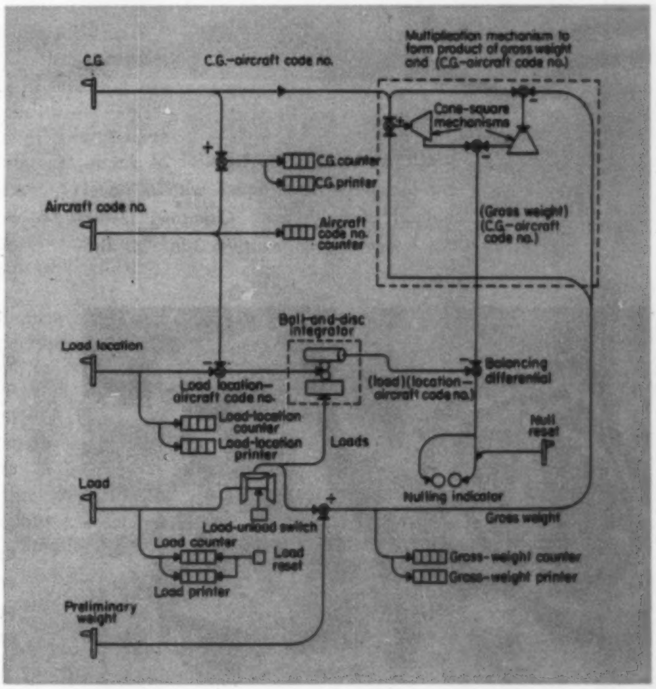
BEAD-CHAIN DRIVES operate the mechanism which prints the final computations of load distribution. Made of stainless steel, the bead chain is first prestressed to avoid stretch during service. Brass driving members are built in two halves which clamp the bead chain and prevent drive slippage.



Is Completely Hand Powered

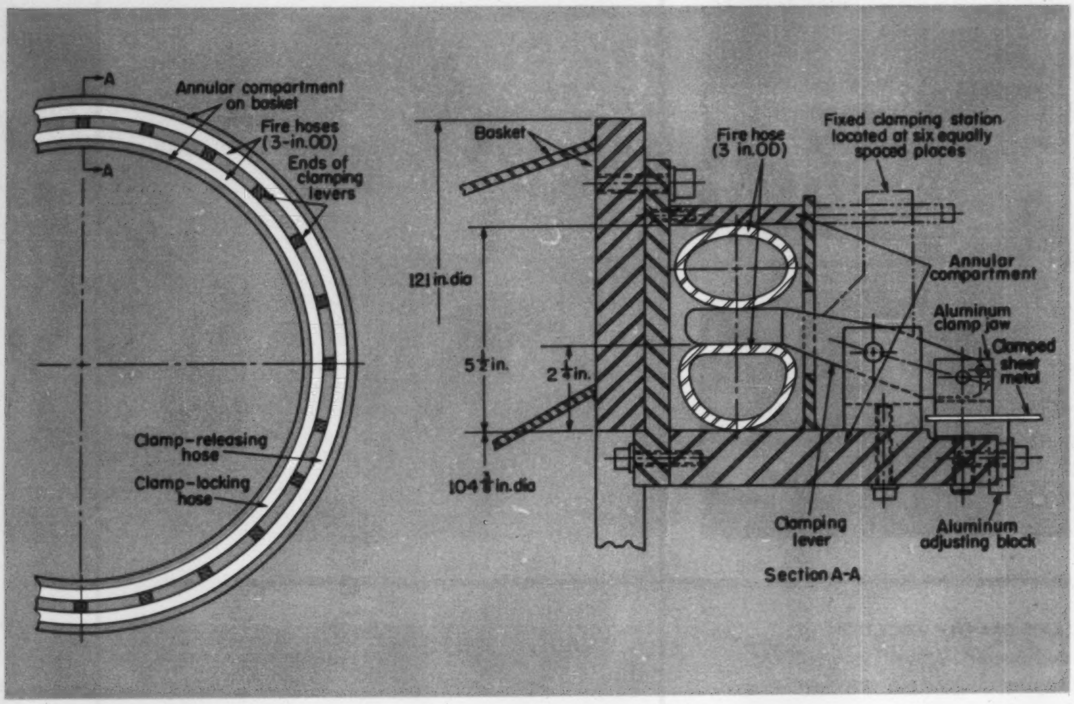

Print-out numbers
Brass driving members


Aircraft code number
Null indicater
Print-out mechanism
Print-out lever
Gross weight
Center-of-gravity location
Load
Load location

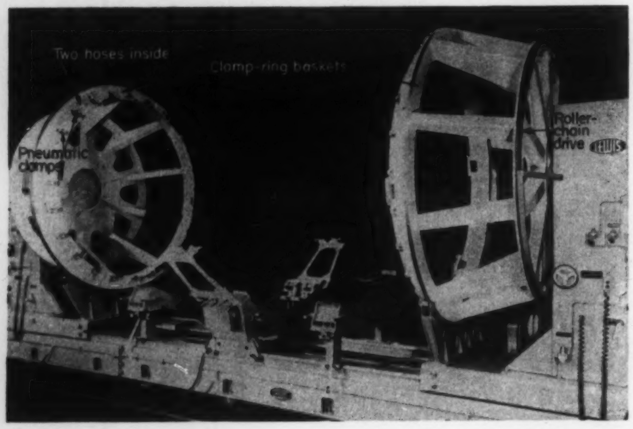

C.G.
C.G.—aircraft code no.
Multiplication mechanism to form product of gross weight and (C.G.—aircraft code no.)
Cone-square mechanisms
C.G. counter
C.G. printer
Aircraft code no.
Aircraft code no. counter
(Gross weight) (C.G.—aircraft code no.)
Ball-and-disc integrator
Load location
Load location—aircraft code no.
(load)(location—aircraft code no.)
Balancing differential
Load-location counter
Load-location printer
Loads
Null reset
Load
Nulling indicator
Gross weight
Load-unload switch
Load counter
Load reset
Load printer
Gross-weight counter
Gross-weight printer
Preliminary weight

CENTER-OF-GRAVITY LOCATION of a loaded aircraft as well as gross weight are found by the all-mechanical computer. Given data include aircraft preliminary c.g. location and weight along with the individual loads and their proposed locations. A ball-and-disc integrator finds the products of individual loads and their locations and maintains a running summation. Two cone-square mechanisms form the product of the final center-of-gravity-location and the gross weight. The outputs of the ball-and-disc integrator and the cone-square multiplication mechanism are compared by a balancing differential and a nulling indicator. When these two outputs are equal, the c.g. is found of the loaded aircraft.

Radial Expansion of Large Air Hoses Synchronizes Multiple-Clamp Actuation


A
A
Annular compartment on basket
Fire hoses (3-in.OD)
Ends of clamping levers
Clamp-releasing hose
Clamp-locking hose
Basket
121 in.dia
5½ in.
2¼ in.
104¾ in.dia
Fire hose (3 in.OD)
Fixed clamping station located at six equally spaced places
Annular compartment
Aluminum clamp jaw
Clamped sheet metal
Clamping lever
Aluminum adjusting block
Section A-A

SIMULTANEOUS OPERATION of 24 clamping members is obtained with a novel method of actuation. Clamping levers are inserted between two 3-in. OD fire hoses which are placed inside an annular compartment. Expansion of one of the hoses under 100 lb of air pressure moves all of the levers to a clamped position. Expansion of the other hose releases the clamps.


Two hoses inside
Clamp-ring baskets
Pneumatic clamps
Roller-chain drive
LEWIS

As reported by Charles E. Huddleston, director of engineering, Lewis Welding and Engineering Corp., Cleveland, the pneumatic clamping system was developed for a new automatic welding machine. It is used in two basket-shaped, clamp-ring assemblies which are located at either end of the machine. Clamps around the periphery of these 10-ft diameter "baskets" lock the ends of cylindrical sections of thin-gage material for fabricating large-diameter missile fuel tanks. The baskets rotate and position the sheet metal for welding and subsequent processing operations.

An Engineering Approach to HYDRAULIC LINES | NO. 3

Selecting Hydraulic Tubing

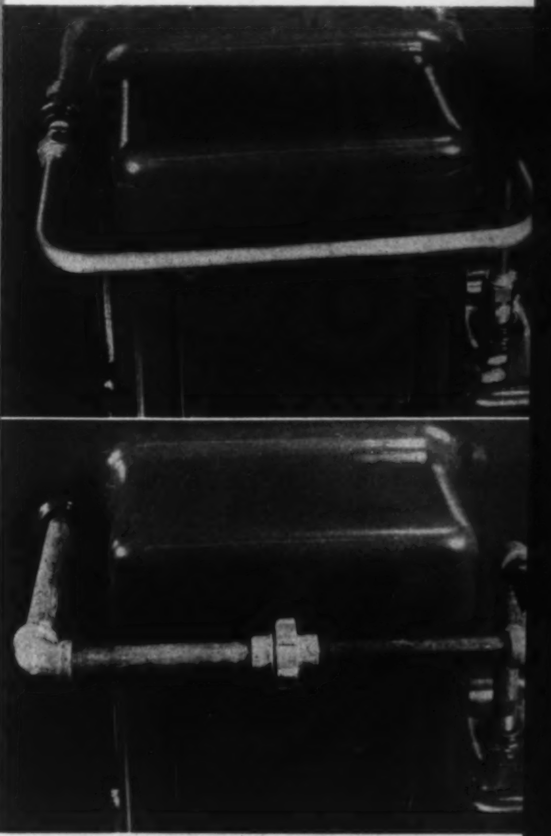
JAROSLAV J. TABOREK
Research and Development Engineer
Phillips Petroleum Co.
Bartlesville, Okla.

HIGH-PRESSURE hydraulic systems require hydraulic lines with wide ranges in wall thickness, high-quality surface finishes, close wall tolerances, and high flexibility. Hydraulic tubing meets all these requirements.

Tubing of many types, sizes, and materials are available to the designer, and hence, the problem is one of selecting the tubing which will give the best performance under service conditions. This third article in a planned program on hydraulic lines discusses the various tubing characteristics and presents charts and tables which can be used in selecting the right type of tubing for the right application.

Despite their differences, all types of tubing have one characteristic in common: They are made of relatively malleable materials. Hence, tubing can be bent into any required shape, which reduces to a minimum the number of fittings necessary for fabrication, Fig. 1. In addition, vibration-resistant fittings are used for connection.

To make the fullest use of the advantages of tubing, specification principles, available types and materials, and installation practices must be considered.



Photos, courtesy Parker Fittings and Hose Div., Parker-Hannifin Corp.

Fig. 1—Tubing installations reduce the number of fittings required, and hence, the number of potential leaks.

Tubing Specifications

In general, hydraulic tubing specifications are set up to serve two purposes: 1. To standardize sizes and types. 2. To increase reliability. Standardization makes possible the interchange of various types of tubing.

Standard Sizes: Tubing is manufactured in common-fraction sizes, and is classified by the outside diameter in inches. The wall thickness which corresponds to a particular diameter is usually expressed as a gage number. Values of equivalent wall thicknesses for various gage numbers are tabulated in Table 1. For example, a typical tubing specification 1 × 16 BWG means a 1-in. OD tubing with a wall thickness of 0.065 in. In addition, most commercially available tubing conforms in size to JIC Hydraulic Standards, which state: Outside tubing diameter shall increase in 1/16-in. increments from ⅛ in. to and including ⅜ in., in ⅛-in. increments from ½ in. to and including 1 in., and in ¼-in. increments above 1 in. The complete range of JIC sizes and dimensions is tabulated in Table 2.

The JIC Standards also specify the tolerances permitted on inside and outside tubing diameters, Table 3. However, to prevent accumulation of tolerances under various interpretations of Table 3, the following qualifications must be observed: 1. When tubing is specified by inside and outside diameters, the wall thickness may vary in accordance with Table 3. 2. When tubing is specified by wall thickness and either the inside or outside diameter, the inside or outside diameter may vary according to Table 3, but the wall thickness must not vary more than 10 per cent for tubing of ½-in. OD and larger, and 15 per cent for tubing less than ½-in. OD.

Wall Thicknesses: One way in which reliability is obtained is by specifying the wall thicknesses which will assure adequate strength.

For calculating the necessary wall thickness of tubing required for a given application, the equation used is

$$s = \frac{p_w\, d_o}{2}\left(\frac{M}{\sigma}\right) \tag{1}$$

where s = wall thickness, in.; p_w = working pressure, psi; d_o = inside diameter, in.; σ = tensile strength, psi; and M = safety factor. Equation 1 is plotted in graph form, Fig. 2, from which wall thicknesses and outside diameters can be determined

Table 1—Wall Thickness Equivalents

Birmingham or Stubs' Iron Wire Gage Size	Equivalent Tube Wall Thickness, s (in.)	Birmingham or Stubs' Iron Wire Gage Size	Equivalent Tube Wall Thickness, s (in.)
1	0.300	16	0.065
2	.284	17	.058
3	.259	18	.049
4	.238	19	.042
5	.220	20	.035
6	0.203	21	0.032
7	.180	22	.028
8	.165	23	.025
9	.148	24	.022
10	.134	25	.020
11	0.120	26	0.018
12	.109	27	.016
13	.095	28	.014
14	.083	29	.013
15	.072	30	.012

Data, courtesy Parker Fittings and Hose Div., Parker-Hannifin Corp.

Table 2—Basic Dimensions for Commercially Available Tubing

Outside Diameter d_o(in.)	Wall Thickness s(in.)	Inside Diameter d_i(in.)	Outside Diameter d_o(in.)	Wall Thickness s(in.)	Inside Diameter d_i(in.)	Outside Diameter d_o(in.)	Wall Thickness s(in.)	Inside Diameter d_i(in.)	Outside Diameter d_o(in.)	Wall Thickness s(in.)	Inside Diameter d_i(in.)
⅛	0.028	0.069	½	0.035	0.430	⅞	0.049	0.777	1¼	0.120	1.010
	.032	.061		.042	.416		.058	.759			
	.035	.055		.049	.402		.065	.745	1½	0.065	1.370
				.058	.384		.072	.731		.072	1.356
3/16	0.032	0.1235		.065	.370		.083	.709		.083	1.334
	.035	.1175		.072	.356		.095	.685		.095	1.310
				.083	.334		.109	.657		.109	1.282
¼	0.035	0.180								.120	1.260
	.042	.166	⅝	0.035	0.555	1	0.049	0.902			
	.049	.152		.042	.541		.058	.884	1¾	0.065	1.620
	.058	.134		.049	.527		.065	.870		.072	1.606
	.065	.120		.058	.509		.072	.856		.083	1.584
				.065	.495		.083	.834		.095	1.560
5/16	0.035	0.2425		.072	.481		.095	.810		.109	1.532
	.042	.2285		.083	.459		.109	.782		.120	1.510
	.049	.2145		.095	.435		.120	.760		.134	1.482
	.058	.1965									
	.065	.1825	¾	0.049	0.652	1¼	0.049	1.152	2	0.065	1.870
				.058	.634		.058	1.134		.072	1.856
⅜	0.035	0.305		.065	.620		.065	1.120		.083	1.834
	.042	.291		.072	.606		.072	1.106		.095	1.810
	.049	.277		.083	.584		.083	1.084		.109	1.782
	.058	.259		.095	.560		.095	1.060		.120	1.760
	.065	.245		.109	.532		.109	1.032		.134	1.732

Data, courtesy Parker Fittings and Hose Div., Parker-Hannifin Corp.

Table 3—Tubing Tolerances (JIC)

Outside Diameter d_o(in.)	Tolerance on Outside Diameter (in.)	Tolerance on Inside Diameter (in.)
¼—½	0.003	——
⅝—1½	0.005	0.005
1½ and up	0.010	0.010

Table 4—Minimum Wall Thickness of Tubing*

Outside Diameter d_o(in.)	Minimum Wall Thickness, s_{min}(in.), for Working Pressures, p_w(psi) 0—500	500—1200	1200—3000
⅜	0.035	0.035	0.060
½	0.035	0.035	0.075
⅝	0.035	0.049	0.090
¾	0.035	0.049	0.109
⅞	0.049	0.065	0.109
1	0.049	0.065	0.120
1½	0.065	0.095	——

*JIC Standards specify that these minimum wall thicknesses should be used even if actual calculations produce smaller values.

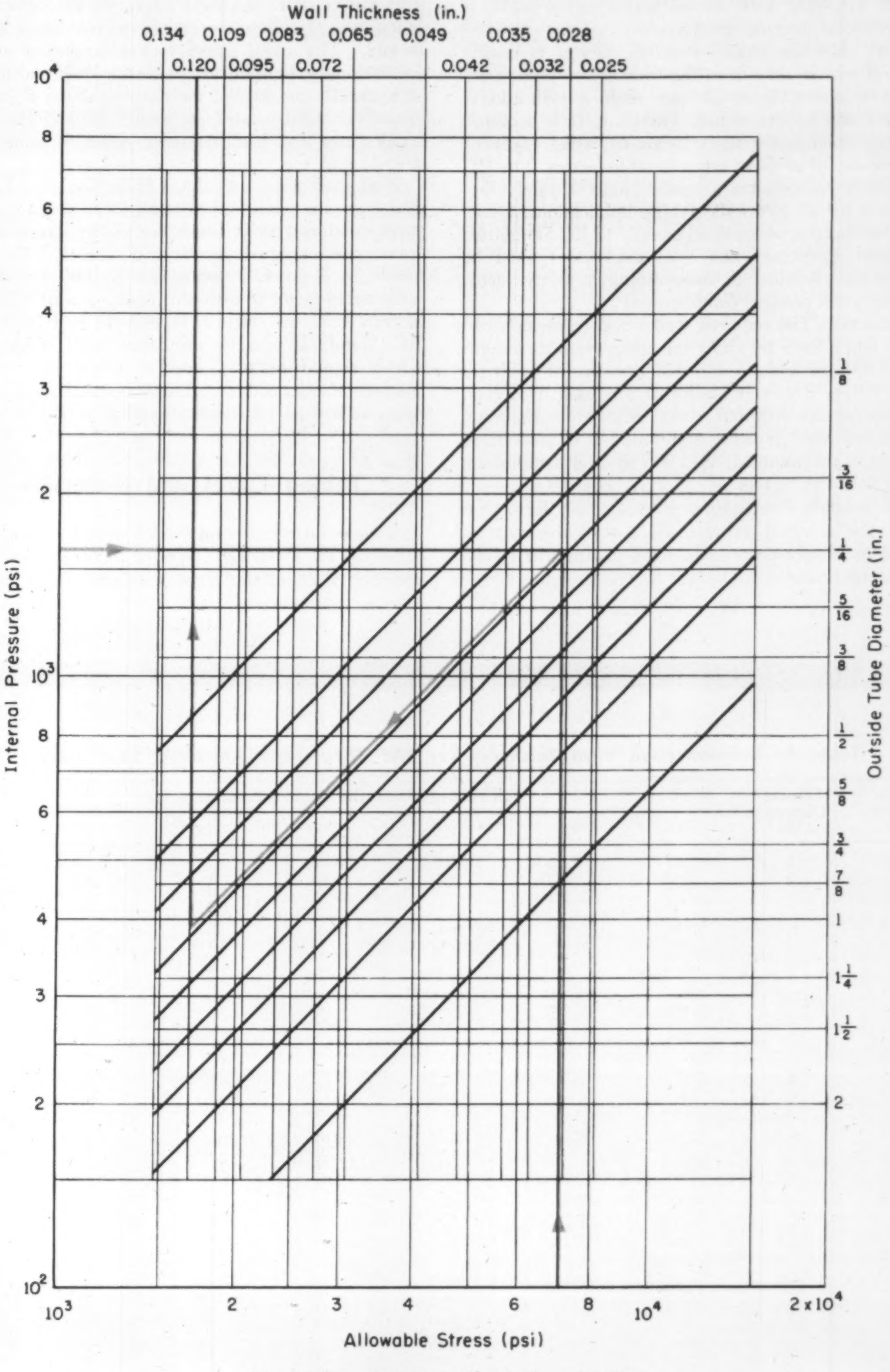


Fig. 2—Chart permits rapid selection of tubing wall thickness and OD for a required pressure and allowable stress. (Based on data from Parker Fittings and Hose Div., Parker-Hannifin Corp.)

when a tubing with an allowable stress, σ/M, is subjected to internal pressures.

Wall thickness calculations are subject to uncertainties which arise from the inability to predict accurately operating conditions such as vibrational stresses and service abuse. Therefore, it is common practice to employ a safety factor, M, which takes into account all of these unpredictable factors. The JIC Standards recommend unconditionally a safety factor of 8 for all hydraulic tubing applications. Also, for installations which must comply to JIC Standards, diameter tolerances and wall thicknesses must be taken into account in determining a safety factor for the worst possible combination.

EXAMPLE: The required wall thickness determined from Fig. 2 for 1-in. OD steel tubing with a strength of 55,000 psi and an internal pressure of 1600 psi is 0.120 in., if a safety factor of 8 is used. However, calculating the required safety factor from Equation 1 for the worst possible accumulation of tolerances, that is, a maximum $d_o = 1.005$ in. and a minimum $s = 0.108$ in., gives $M = 7.37$. Hence, since the worst possible combination gives a safety factor less than the nominal value of 8, a wall thickness of 0.134 in. would have to be used to conform to JIC Standards.

Many practical industrial applications are, however, subjected to less rigid interpretation of the JIC Standards, or follow certain experience-based safety factors. The usual safety factors employed are: 4 for stationary, noncritical applications with minimum of hydraulic shocks and mechanical abuse; 6 for average industrial conditions; and 8 for JIC Standard applications and installations exposed to severe hydraulic and mechanical shocks and abuse.

Wall thicknesses calculated from Equation 1 will, under certain conditions of small OD's and low pressures, produce results which are inadequate to withstand the expected mechanical abuses. For example, a ⅜-in. OD tubing for a 1000 psi system with safety factor of 6 would require a wall thickness of only 0.02 in. Hence, to exclude such extremes, JIC Standards specify minimum wall thicknesses which should be used even if actual calculations produce smaller values. These recommended minimum wall thicknesses are compiled in Table 4.

Tubing Types and Materials

A wide variety of commercial tubing is available, differing in materials, type of manufacture, and quality. Each of the types is suitable for a specific

Table 5—Recommended Wall Thickness for SAE 1010, Fully Annealed Steel Tubing

Safety Factor M	Outside Diameter d_o (in.)	Wall Thickness, s (in.), for Working Pressures, p_w (psi)						
		500	1000	1500	2000	2500	3000	4000
4	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	.032	.032
	¼	.035	.035	.035	.035	.035	.035	.035
	5/16	.035	.035	.035	.035	.035	.035	.049
	⅜	0.035	0.035	0.035	0.035	0.035	0.035	0.049
	½	.035	.035	.035	.035	.049	.049	.065
	⅝	.049	.049	.049	.049	.049	.065	.083
	¾	.049	.049	.049	.049	.065	.065	.095
	⅞	0.049	0.049	0.049	0.065	0.065	0.095	——
	1	.049	.049	.049	.065	.110	.110	.130
	1¼	.083	.083	.083	.083	.120	.120	——
	1½	.095	.095	.095	.095	.130	.130	——
6	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	.032	.035
	¼	.035	.035	.035	.035	.035	.035	.049
	5/16	.035	.035	.035	.035	.035	.049	.058
	⅜	0.035	0.035	0.035	0.035	0.049	0.058	0.072
	½	.035	.035	.035	.049	.072	.072	.095
	⅝	.049	.049	.049	.065	.083	.083	.130
	¾	.049	.049	.065	.095	.095	.110	.148
	⅞	0.049	0.049	0.065	0.095	——	——	——
	1	.049	.049	.065	.110	0.120	0.148	0.203
	1¼	.083	.083	.083	.120	——	——	——
	1½	.095	.095	.130	.130	——	——	——
8	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	——	——
	¼	.035	.035	.035	.035	.049	.049	.065
	5/16	.035	.035	.035	.049	.049	——	——
	⅜	0.035	0.035	0.035	0.049	0.058	0.072	0.095
	½	.035	.035	.049	.072	.083	.095	.130
	⅝	.049	.049	.065	.083	.110	.120	.165
	¾	.049	.049	.065	.095	.120	.148	——
	⅞	0.049	0.065	0.095	——	——	——	——
	1	.049	.065	.110	0.130	0.165	0.203	——
	1¼	.083	.083	.120	——	——	——	——
	1½	.095	.095	.130	——	——	——	——

Data, courtesy Parker Fittings and Hose Div., Parker-Hannifin Corp.

application. A review of the important types will serve as a guide in selecting the most applicable tubing.

Steel Tubing: Steel is the only tubing material permitted by JIC Standards without restrictions, and the following specifications must be met:

> SAE 1010 dead-soft, cold-drawn, seamless steel tubing, or equivalent shall be used in conjunction with steel fittings. The tubing shall conform to the physical requirements of 55,000 psi minimum tensile strength, and a minimum of 40 per cent elongation in 2 in. For tubes with an OD of ⅜ in. or less, and a wall thickness of 0.035 in. or less, a minimum elongation of 30 per cent is permitted. A 3-in. section cut from the tubing shall not crack or show any flaws when flattened between parallel plates to three times the wall thickness of the tube.

The elongation and flattening test properties are required mainly to assure proper flaring and bending quality. Steel tubing which complies with these specifications is available in a wide range in fully annealed, seamless-quality wall thicknesses. The recommended sizes, most readily available, are shown as functions of working pressures and safety factors in Table 5.

The newest steel tubing available is a resistance-welded hydraulic tubing. Special processes are used which produce tubing quality comparable to that of seamless tubing. This tubing has a built-in quality control, since the material can be inspected in flat sheets and closer tolerances can be obtained. Although this tubing has not yet received full approval from JIC and other standard organizations, it has been accepted for use by many companies.

Stainless-Steel Tubing: For large diameters and for very high pressures, the required wall thickness of SAE 1010 tubing is occasionally too large for bending and flaring. Hence, for critical applications, such as in aircraft hydraulic systems, stainless-steel tubing is used. This tubing is available in seamless quality, fully annealed, and suitable for bending and flaring. Dimensions and tolerances of stainless-steel tubing correspond to those specified in carbon-steel tubing standards. Tensile strength for stainless-steel tubing is assumed as 85,000 psi. Based on this value, but subject to minimum wall thickness requirements, Table 6 gives the commercially preferred sizes to be used for working pressures up to 5000 psi with safety factors of 4, 6, and 8.

Copper Tubing: Copper tubing comes in seamless, annealed quality in the standard dimensions. The

Table 6—Recommended Wall Thickness for 18-8 Fully Annealed Stainless-Steel Tubing

Safety Factor M	Outside Diameter d_o(in.)	Wall Thickness, s (in.), for Working Pressures, p_w (psi) 500	1000	1500	2000	2500	3000	4000	5000
4	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	.032	.032	.032
	¼	.035	.035	.035	.035	.035	.035	.035	.035
	5/16	.035	.035	.035	.035	.035	.035	.035	.035
	⅜	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.049
	½	.035	.035	.035	.035	.035	.035	.049	.065
	⅝	.049	.049	.049	.049	.049	.049	.065	.083
	¾	.049	.049	.049	.049	.049	.049	.072	.095
	⅞	0.049	0.049	0.049	0.049	0.049	0.065	0.095	—
	1	.049	.049	.049	.049	.065	.110	.110	—
	1¼	.083	.083	.083	.083	.083	.120	.120	—
	1½	.095	.095	.095	.095	.095	.130	.130	—
6	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	.032	.032	.032
	¼	.035	.035	.035	.035	.035	.035	.035	.049
	5/16	.035	.035	.035	.035	.035	.035	.049	.058
	⅜	0.035	0.035	0.035	0.035	0.035	0.049	0.058	—
	½	.035	.035	.035	.035	.049	.072	.072	—
	⅝	.049	.049	.049	.049	.065	.083	—	—
	¾	.049	.049	.049	.049	.065	.095	—	—
	⅞	0.049	0.049	0.065	0.065	0.095	0.095	—	—
	1	.049	.049	.065	.065	.110	.110	—	—
	1¼	.083	.083	.083	.083	.120	—	—	—
	1½	.095	.095	.095	.130	.130	—	—	—
8	⅛	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	3/16	.032	.032	.032	.032	.032	.032	.035	—
	¼	.035	.035	.035	.035	.035	.035	.049	—
	5/16	.035	.035	.035	.035	.035	.049	.058	—
	⅜	0.035	0.035	0.035	0.035	0.049	0.058	—	—
	½	.035	.035	.035	.049	.072	.072	—	—
	⅝	.049	.049	.049	.065	.083	—	—	—
	¾	.049	.049	.065	.095	.095	—	—	—
	⅞	0.049	0.049	0.065	0.095	—	—	—	—
	1	.049	.049	.065	.110	—	—	—	—
	1¼	.083	.083	.120	.120	—	—	—	—
	1½	.095	.095	.130	.130	—	—	—	—

Data, courtesy Parker Fittings and Hose Div., Parker-Hannifin Corp.

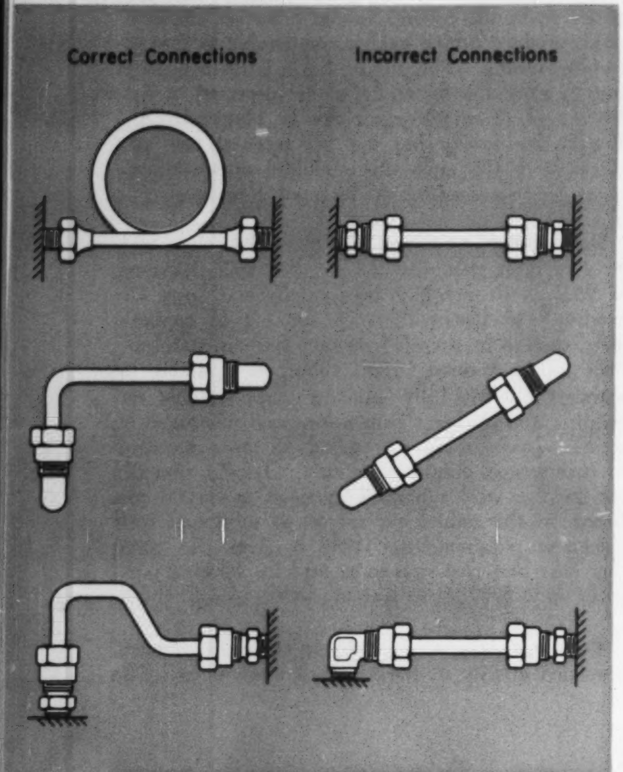


Fig. 3—Correct and incorrect methods of installing tubing.

JIC Standards restrict the use of copper by stating: "Copper tubing or copper alloy fittings are not permissible for use with petroleum base fluids." The reason for this restriction is that copper acts as an oil-oxidation catalyst and tends to work-harden when flared. In addition, copper tubing displays poor resistance to vibration. The use of copper tubing is therefore limited to circuits for stationary applications at low pressure, and to air circuits, which are not subject to JIC Standards. Strength calculation values for copper are based on a tensile strength of 26,000 psi.

Aluminum Tubing: Aluminum tubing of seamless quality has good bending and flaring properties and is mentioned in JIC Standards for low pressure applications. For 5050-0 aluminum, a tensile strength of 17,000 psi is used in calculations.

Selection and Application Practices

Since tubing walls are thin, and tubing materials soft and strong, tubing assemblies can be bent into desired shapes to eliminate potential leak-spots by reducing the number of fittings. In addition, since tubing bends have an effect on the pressure lost in lines a minimum radius of $3\frac{1}{2}$ diameters is recommended in bending tubing.

Tube joining is accomplished by means of leak-resistant flared or flareless fittings. The swivel nut of the fittings permits quick removal and repeated assembly which complies with the JIC specification: All piping connections shall be so designed and installed as to permit quick removal and reassembly by means of hand tools.

Tubing is in many respects the most preferable type of line for hydraulic systems, since it combines the adaptability of bending and flaring with high strength, vibration resistance, and heat conductivity. Carbon-steel tubing of seamless quality is used in the majority of applications, but other types excel in certain applications.

Several simple rules should be observed for proper tubing applications:

1. Bend tubes wherever necessary to eliminate angular fittings.
2. Never connect two line terminals with a straight piece of tubing, especially when the distance is short. A loop or additional bend accommodates tolerances of the tubing assembly as well as tolerances in the positioning of the ports to be connected. Bends will also allow for thermal expansion, absorb vibration, and accommodate other mechanical stresses in the tubing system. Fig. 3 shows several do's and don'ts for tubing connections.
3. Support long tubing runs at frequent intervals to eliminate resonant vibrations and stresses due to deflection.
4. Allow sufficient straight length from the flared tubing end to the start of a bend to permit swivel nut motion during assembly. This length varies with different types of fittings.
5. Design the individual tubing sections either symmetrical so that they can be assembled from either end, or with intentional asymmetry to help in recognizing the proper positioning of the section.

The fourth article in this planned program will be "Selecting Hydraulic Pipes" and will discuss the factors which affect the application of pipes to specific systems. As a part of this program, previous articles appeared in the April 16 and 30, 1959, issues of MACHINE DESIGN.

They Say . . .

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Adjusting Performance of

THERMOSTATIC BIMETALS

Simple equations speed calculation of new element dimensions required to satisfy different response specifications

C. F. ALBAN and **C. C. PERRY**
Chief Engineer, W. M. Chace Co.
Detroit
Research Consultant
Royal Oak, Mich.

RESPONSE of a cantilever bimetal element—deflection and force exhibited during a temperature change—is influenced by several factors. Flexivity and resistivity, inherent properties of bimetal materials, determine deflection and electrical resistance of an element. These properties are built into the material within certain tolerances. Not much can be done to change flexivity and resistivity if response of the element does not meet performance requirements. However, bimetal response can be altered by changing either a single dimension of the element or any combination of length, thickness, and width.

Need to change dimensions may arise under two different circumstances: 1. When closer performance tolerances are required than are consistent with tolerances on flexivity and/or resistivity. 2. When performance of a bimetal element is to be altered to satisfy different specifications.

One way to adjust the design is to undertake a series of new calculations to obtain a set of dimensions that will satisfy performance specifications. This process, however, is quite cumbersome. Also, it can be rather ineffective when more than one dimension needs to be modified or when more than one performance requirement is to be adjusted.

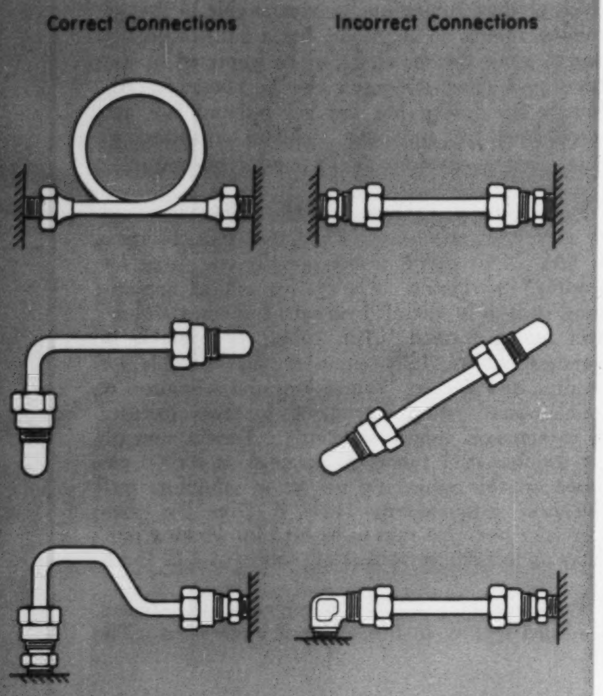
All such problems can be solved most easily by dimensional analysis. This technique has been used to develop a group of similitude equations for cantilever bimetal elements. Simple, general performance-adjustment ratios are the result. These ratios, shown in the accompanying table, produce the correct change in any element dimension or combination of dimensions required to bring about a specified change in any bimetal performance parameter or combination of parameters.

Nomenclature

b = Width, in.
D = Deflection, in. (strips)
E = Voltage, volts
I = Current, amp
L = Length, in.
P = Force or load, oz
R = Resistance, ohms
t = Thickness, in.

Ratio Significance: (See Nomenclature) Assume that a bimetal element has these dimensions: Length L_0, thickness t_0, and width b_0. Also, it has the initial attributes of deflection D_0, force P_0, and resistance R_0. Now, assume that the following new performance specifications, deflection D_1, force P_1, and resistance R_1, are required, and that the new dimensions which will produce such performance are length L_1, thickness t_1, and width b_1.

Length, thickness, and width should be changed to achieve a desired change or changes in deflec-



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Need to change dimensions may arise under two different circumstances: 1. When closer performance tolerances are required than are consistent with tolerances on flexivity and/or resistivity. 2. When performance of a bimetal element is to be altered to satisfy different specifications.

One way to adjust the design is to undertake a series of new calculations to obtain a set of dimensions that will satisfy performance specifications. This process, however, is quite cumbersome. Also, it can be rather ineffective when more than one dimension needs to be modified or when more than one performance requirement is to be adjusted.

All such problems can be solved most easily by dimensional analysis. This technique has been used to develop a group of similitude equations for cantilever bimetal elements. Simple, general performance-adjustment ratios are the result. These ratios, shown in the accompanying table, produce the correct change in any element dimension or combination of dimensions required to bring about a specified change in any bimetal performance parameter or combination of parameters.

Nomenclature

b = Width, in.
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E = Voltage, volts
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Length, thickness, and width should be changed to achieve a desired change or changes in deflec-

Bimetal Performance-Adjustment

Bimetal Dimension	Deflection, D	Resistance, R	Thermal Force, P	Deflection, D, and Resistance, R
Length, L	$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}}$ ◄	$\frac{L_1}{L_0} = \frac{R_1}{R_0}$ ◄	$\frac{L_1}{L_0} = \frac{P_0}{P_1}$ ◄	$\frac{L_1}{L_0} = \frac{R_1}{R_0} = \sqrt{\frac{D_1}{D_0}}$ $\frac{D_1}{D_0}\left(\frac{R_0}{R_1}\right)^2 \equiv 1$
Thickness, t	$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◄	$\frac{t_1}{t_0} = \frac{R_0}{R_1}$ ◄	$\frac{t_1}{t_0} = \sqrt{\frac{P_1}{P_0}}$ ◄	$\frac{t_1}{t_0} = \frac{D_0}{D_1} = \frac{R_0}{R_1}$ $\frac{D_1 R_0}{D_0 R_1} \equiv 1$
Width, b		$\frac{b_1}{b_0} = \frac{R_0}{R_1}$ ◄	$\frac{b_1}{b_0} = \frac{P_1}{P_0}$ ◄	$\frac{b_1}{b_0} = \frac{R_0}{R_1}$ $\frac{D_1}{D_0} \equiv 1$
Length, L, and Thickness, t	$\frac{t_1}{t_0} = \left(\frac{L_1}{L_0}\right)^2 \frac{D_0}{D_1}$ $\frac{L_1}{L_0} = \sqrt{\frac{t_1 D_1}{t_0 D_0}}$	$\frac{L_1}{L_0} = \frac{R_1 t_1}{R_0 t_0}$ $\frac{t_1}{t_0} = \frac{L_1 R_0}{L_0 R_1}$	$\frac{L_1}{L_0} = \left(\frac{t_1}{t_0}\right)^2 \frac{P_0}{P_1}$ $\frac{t_1}{t_0} = \sqrt{\frac{P_1 L_1}{P_0 L_0}}$	$\frac{L_1}{L_0} = \frac{D_1 R_0}{D_0 R_1}$ ◄ $\frac{t_1}{t_0} = \frac{D_1}{D_0}\left(\frac{R_0}{R_1}\right)^2$ ◄
Thickness, t, and Width, b	$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◄	$\frac{t_1}{t_0} = \frac{R_0 b_0}{R_1 b_1}$ $\frac{b_1}{b_0} = \frac{R_0 t_0}{R_1 t_1}$	$\frac{t_1}{t_0} = \sqrt{\frac{P_1 b_0}{P_0 b_1}}$ $\frac{b_1}{b_0} = \frac{P_1}{P_0}\left(\frac{t_0}{t_1}\right)^2$	$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◄ $\frac{b_1}{b_0} = \frac{D_1 R_0}{D_0 R_1}$ ◄
Length, L, and Width, b	$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}}$ ◄	$\frac{L_1}{L_0} = \frac{R_1 b_1}{R_0 b_0}$ $\frac{b_1}{b_0} = \frac{L_1 R_0}{L_0 R_1}$	$\frac{L_1}{L_0} = \frac{b_1 P_0}{b_0 P_1}$ $\frac{b_1}{b_0} = \frac{P_1 L_1}{P_0 L_0}$	$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}}$ ◄ $\frac{b_1}{b_0} = \sqrt{\frac{D_1}{D_0}\left(\frac{R_0}{R_1}\right)^2}$ ◄
Length, L, Thickness, t, and Width, b	$\frac{t_1}{t_0} = \left(\frac{L_1}{L_0}\right)^2 \frac{D_0}{D_1}$ $\frac{L_1}{L_0} = \sqrt{\frac{t_1 D_1}{t_0 D_0}}$	$\frac{L_1}{L_0} = \frac{R_1 t_1 b_1}{R_0 t_0 b_0}$ $\frac{t_1}{t_0} = \frac{L_1 R_0 b_0}{L_0 R_1 b_1}$ $\frac{b_1}{b_0} = \frac{L_1 R_0 t_0}{L_0 R_1 t_1}$	$\frac{L_1}{L_0} = \frac{b_1 P_0}{b_0 P_1}\left(\frac{t_1}{t_0}\right)^2$ $\frac{t_1}{t_0} = \sqrt{\frac{P_1 L_1 b_0}{P_0 L_0 b_1}}$ $\frac{b_1}{b_0} = \frac{P_1 L_1}{P_0 L_0}\left(\frac{t_0}{t_1}\right)^2$	$\frac{L_1}{L_0} = \frac{D_1 R_0 b_0}{D_0 R_1 b_1}$ $\frac{t_1}{t_0} = \frac{D_1}{D_0}\left(\frac{R_0 b_0}{R_1 b_1}\right)^2$ $\frac{b_1}{b_0} = \sqrt{\frac{D_1 L_0}{D_0 L_1}\left(\frac{R_0}{R_1}\right)^2}$ $\frac{b_1}{b_0} = \frac{D_1 R_0 L_0}{D_0 R_1 L_1}$

Using the table . . .

1. It is assumed that in changing dimensions of the element, basic properties of the bimetal material remain unchanged.
2. Thermal force is that force generated by a restrained element during a temperature change.
3. Areas left blank indicate that adjustment of a performance parameter by a change in a particular element dimension is impossible or impractical.
4. Equations identified by arrows are those which are most feasible for a particular performance change. Equations not so marked are those in which dimensions are overdetermined or underdetermined.
5. Performance parameters, other than those specifically listed at the top of each column, will vary with dimensional changes according to the basic bimetal equations.

Ratios for Cantilever Elements

Deflection, *D*, and Thermal Force, *P*	Resistance, *R*, and Thermal Force, *P*	Deflection, *D* (100% heat from I^2R, at constant *I*)	Deflection, *D* (100% heat from I^2R, at constant *E*)
$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}} = \frac{P_0}{P_1}$ $\frac{D_1}{D_0}\left(\frac{P_1}{P_0}\right)^2 \equiv 1$	$\frac{L_1}{L_0} = \frac{R_1}{R_0} = \frac{P_0}{P_1}$ $\frac{R_1 P_1}{R_0 P_0} \equiv 1$	$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}}$ ◀	
$\frac{t_1}{t_0} = \frac{D_0}{D_1} = \sqrt{\frac{P_1}{P_0}}$ $\left(\frac{D_1}{D_0}\right)^2 \frac{P_1}{P_0} \equiv 1$	$\frac{t_1}{t_0} = \frac{R_0}{R_1} = \sqrt{\frac{P_1}{P_0}}$ $\frac{R_1}{R_0}\sqrt{\frac{P_1}{P_0}} \equiv 1$	$\frac{t_1}{t_0} = \sqrt[3]{\frac{D_0}{D_1}}$ ◀	$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◀
$\frac{b_1}{b_0} = \frac{P_1}{P_0}$ $\frac{D_1}{D_0} \equiv 1$	$\frac{b_1}{b_0} = \frac{R_0}{R_1} = \frac{P_1}{P_0}$ $\frac{P_1 R_1}{P_0 R_0} \equiv 1$	$\frac{b_1}{b_0} = \sqrt{\frac{D_0}{D_1}}$ ◀	
$\frac{L_1}{L_0} = \sqrt[3]{\frac{P_1}{P_0}\left(\frac{D_1}{D_0}\right)^2}$ ◀ $\frac{t_1}{t_0} = \sqrt[3]{\frac{D_1}{D_0}\left(\frac{P_1}{P_0}\right)^2}$ ◀	$\frac{L_1}{L_0} = \left(\frac{R_1}{R_0}\right)^2 \frac{P_1}{P_0}$ ◀ $\frac{t_1}{t_0} = \frac{R_1 P_1}{R_0 P_0}$ ◀	$\frac{L_1}{L_0} = \sqrt{\left(\frac{t_1}{t_0}\right)^3 \frac{D_1}{D_0}}$ $\frac{t_1}{t_0} = \sqrt[3]{\left(\frac{L_1}{L_0}\right)^2 \frac{D_0}{D_1}}$	$\frac{t_0}{t_1} = \frac{D_1}{D_0}$ ◀
$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◀ $\frac{b_1}{b_0} = \frac{P_1}{P_0}\left(\frac{D_1}{D_0}\right)^2$ ◀	$\frac{t_1}{t_0} = \frac{P_1 R_1}{P_0 R_0}$ ◀ $\frac{b_1}{b_0} = \frac{P_0}{P_1}\left(\frac{R_0}{R_1}\right)^2$ ◀	$\frac{t_1}{t_0} = \sqrt[3]{\left(\frac{b_0}{b_1}\right)^2 \frac{D_0}{D_1}}$ $\frac{b_1}{b_0} = \sqrt{\left(\frac{t_0}{t_1}\right)^3 \frac{D_0}{D_1}}$	$\frac{t_1}{t_0} = \frac{D_0}{D_1}$ ◀
$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}}$ ◀ $\frac{b_1}{b_0} = \frac{P_1}{P_0}\sqrt{\frac{D_1}{D_0}}$ ◀	$\frac{L_1}{L_0} = \frac{b_1 R_1}{b_0 R_0} = \frac{b_1 P_0}{b_0 P_1}$ $\frac{b_1}{b_0} = \frac{L_1 P_1}{L_0 P_0} = \frac{L_1 R_0}{L_0 R_1}$ $\frac{P_1}{P_0} = \frac{R_0}{R_1}$	$\frac{L_1}{L_0} = \sqrt{\left(\frac{b_1}{b_0}\right)^2 \frac{D_1}{D_0}}$ $\frac{b_1}{b_0} = \sqrt{\left(\frac{L_1}{L_0}\right)^2 \frac{D_0}{D_1}}$	
		Deflection, *D*, Resistance, *R*, and Thermal Force, *P*	
$\frac{L_1}{L_0} = \sqrt[3]{\frac{P_1 b_0}{P_0 b_1}\left(\frac{D_1}{D_0}\right)^2}$ $\frac{t_1}{t_0} = \sqrt[3]{\left(\frac{P_1 b_0}{P_0 b_1}\right)^2 \frac{D_1}{D_0}}$ $\frac{b_1}{b_0} = \frac{P_1}{P_0}\left(\frac{D_1}{D_0}\right)^2\left(\frac{L_0}{L_1}\right)^3$ $\frac{b_1}{b_0} = \sqrt{\left(\frac{P_1}{P_0}\right)^2\left(\frac{t_0}{t_1}\right)^3 \frac{D_1}{D_0}}$	$\frac{L_1}{L_0} = \left(\frac{R_1}{R_0}\right)^2 \frac{P_1 b_1}{P_0 b_0}$ $\frac{t_1}{t_0} = \frac{R_1 P_1}{R_0 P_0}$ $\frac{b_1}{b_0} = \frac{L_1 b_0}{L_0 b_1}\left(\frac{R_0}{R_1}\right)^2$	$\frac{L_1}{L_0} = \sqrt{\frac{D_1 P_1 R_1}{D_0 P_0 R_0}}$ ◀ $\frac{t_1}{t_0} = \frac{P_1 R_1}{P_0 R_0}$ ◀ $\frac{b_1}{b_0} = \sqrt{\frac{D_1 P_0}{D_0 P_1}\left(\frac{R_0}{R_1}\right)^3}$ ◀	

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6. Deflection, force, and resistance are treated as independent variables and are adjusted independently in all columns except the two on the extreme right-hand side of the chart.
7. If significantly less than 100 per cent of the heat for actuating the bimetal is generated by current flowing through the element, deflection and resistance properties must be controlled and/or adjusted independently.
8. In the special case, in which essentially 100 per cent of the actuating heat is supplied by current flowing through the bimetal, resistance can be considered incidental and only actual deflection is important. It is possible to adjust deflection of the bimetal by adjusting the width of the element as indicated by the appropriate equation.

tion, force, and resistance according to these three basic equations:

$$L_1 = L_0 \sqrt{\frac{D_1 P_1 R_1}{D_0 P_0 R_0}} \qquad (1)$$

$$t_1 = t_0 \frac{P_1 R_1}{P_0 R_0} \qquad (2)$$

$$b_1 = b_0 \sqrt{\frac{D_1 P_0}{D_0 P_1} \left(\frac{R_0}{R_1} \right)^3} \qquad (3)$$

In many practical cases, adjustment of all three dimensions of the cantilever element will not be feasible. Similarly, it may not be necessary to adjust thermal deflection, thermal force, and electrical resistance simultaneously. Therefore, in addition to Equations 1, 2, and 3, equations have been derived for all possible cases including those requiring changes in one, two, or three performance parameters and in one, two, or three element dimensions. Although derived for straight-sided cantilever elements, equations shown in the table are applicable to straight-sided, U-shaped, and simply supported elements.

To demonstrate use of the table, the following examples show how to adjust or predict bimetal performance. Magnitudes of changes used in the examples are greater than would be necessitated by production variables. They could occur only through an actual change in performance specifications. Similarly, changes in performance specifications need not be limited to magnitudes used in the sample problems.

In all examples, existing or initial performance conditions D_0, P_0, and R_0 are taken as unity.

Example 1: Assume that in a certain application of a cantilever bimetal element, it would be desirable to increase deflection by 10 per cent for a specified temperature change and that, for some practical reason, only the length of the element can be adjusted. That is, $D_1/D_0 = 1.10$. The problem is to find new length L_1.

Since the problem involves only deflection and length, the correct equation is found in the table at the intersection of vertical column, "Deflection, *D*," and horizontal row, "Length, *L*." With this equation,

$$\frac{L_1}{L_0} = \sqrt{\frac{D_1}{D_0}} = \sqrt{1.10} = 1.049$$

or

$$L_1 = 1.049\, L_0$$

Thus, the initial length of the element should be increased by 4.9 per cent for a 10-per cent increase in deflection. Force and resistance of the element will also change, but these factors were considered incidental to the problem.

Example 2: For a more complex case, assume that it is necessary to increase thermal deflection of a bimetal element by 8 per cent and increase torque, or force-generating capacity, by 5 per cent. Also, assume that only the width and thickness of the element can be adjusted. Therefore, $D_1/D_0 = 1.08$ and $P_1/P_0 = 1.05$. The problem is to find new width b_1, and new thickness t_1.

In the table, two equations are found at the intersection of performance parameters *D* and *P* and element dimensions *t* and *b*. Then,

$$\frac{t_1}{t_0} = \frac{D_0}{D_1} = \frac{1}{1.08} = 0.926$$

$$t_1 = 0.926\, t_0$$

$$\frac{b_1}{b_0} = \frac{P_1}{P_0} \left(\frac{D_1}{D_0} \right)^2 = 1.05(1.08)^2 = 1.225$$

$$b_1 = 1.225\, b_0$$

To achieve the required changes in performance simultaneously, thickness of the element should be reduced to 92.6 per cent of its initial value, and the width should be increased by 22.5 per cent.

Example 3: Consider a special case in which a bimetal receives 100 per cent of its actuating heat from current flow through the element. Assume that deflection of the element is 7 per cent too low, that a fixed current *I* (independent of bimetal dimensions) flows through the element, and that the only dimension which can be changed is thickness. From the table,

$$\frac{t_1}{t_0} = \sqrt[3]{\frac{D_0}{D_1}} = \sqrt[3]{\frac{1}{1.07}} = 0.978$$

$$t_1 = 0.978\, t_0$$

Thus, a 2.2-per cent reduction in thickness increases the resistance (and heat input), decreases the mass of bimetal, and increase free thermal deflection to bring about the desired net result.

Example 4: For the most complex case, consider a cantilever bimetal element in which it is wished to reduce deflection by 5 per cent, increase force by 3 per cent, and decrease resistance by 6 per cent. Therefore, $D_1/D_0 = 0.95$, $P_1/P_0 = 1.03$, and $R_1/R_0 = 0.94$. Assuming that all three element dimensions are subject to change, what are new values L_1, t_1, and b_1? From the table,

$$\frac{L_1}{L_0} = \sqrt{\frac{D_1 P_1 R_1}{D_0 P_0 R_0}} = \sqrt{0.95(1.03)(0.94)} = 0.959$$

$$\frac{t_1}{t_0} = \frac{P_1 R_1}{P_0 R_1} = 1.03(0.94) = 0.968$$

$$\frac{b_1}{b_0} = \sqrt{\frac{D_1 P_0}{D_0 P_1} \left(\frac{R_0}{R_1} \right)^3} = \sqrt{0.95(0.97)(1.06)^3} = 1.053$$

and

$$L_1 = 0.959\, L_0$$

$$t_1 = 0.968\, t_0$$

$$b_1 = 1.053\, b_0$$

These relative changes in dimensions will bring about the simultaneous adjustments required in all three performance parameters for the element.

DESIGN ENGINEERING SHOW GUIDE

. . . a trip down the aisles plus a pre-Show panorama of new products that will be on display

COMMUNICATION—vital in some fields and necessary in all—is highly important to design engineering. The man behind the design must keep contact with basic "hardware" and the people who produce it. One means of keeping in touch is the annual Design Engineering Show.

This Show, born in Philadelphia in 1956, returns to Convention Hall for four days beginning May 25. Thousands of components, accompanied by experts on their application, will be arrayed for the benefit of design-engineer visitors.

The concurrent ASME Conference will present papers covering materials, power and control, mechanisms, management, and engineering organization.

Conference and exhibits are previewed in this Show Guide. If you are going to the Show, stop in at MACHINE DESIGN's booth No. 333 and pick up a bound copy of the guide; if you're staying behind to mind the store, put your feet up and let the following pages provide a tour of the show.

Here are the facts . . .

Place: Convention Hall, Philadelphia

Dates: May 25-28, 1959

Hours: Conference
May 25—10:00 a.m. to noon
May 26, 27, 28—9:30 a.m. to noon
Show
May 25, 27, 28—noon to 5:30 p.m.
May 26—noon to 9:30 p.m.

Fees: For the Show—$2, payable at the registration desk
For the Conference—$5 for ASME members, $10 for nonmembers; also includes admission to the Show

. . . and here is the Show . . .

New Products on Display .... Page 200
Conference Program 224
Exhibitors Listed Alphabetically 227
Floor Plan of Convention Hall 228

DESIGN
ENGINEERING
Show AND
CONFERENCE

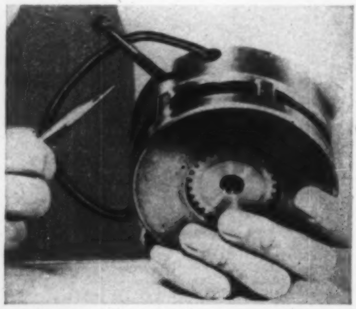
★EXHIBITORS

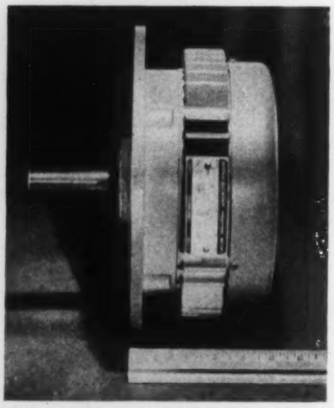
81	I-T-E Circuit Breaker Co.
83	National Precision Div., Beryllium Corp.
88	Sanders Associates Inc.
92	J. Frank Motson Co.
93	Penn Engineering & Mfg. Corp.
102	Designers Metal Corp.
105	Olin Mathieson Chemical Corp., Metals Div.
107	Binks Mfg. Co.
114	Owens-Corning Fiberglas Corp.
115	Handy & Harman
117	Armstrong Cork Co.
118	Doehler-Jarvis Div., National Lead Co.
121	Messinger Bearings, Inc.
130	Dow Chemical Co.
131	E. I. du Pont de Nemours & Co. Inc.
132	Sweet's Catalog Service Div., F. W. Dodge Corp.
204	Jones & Laughlin Steel Corp., Stainless and Strip Div.
205	Ohio Seamless Tube Div., Copperweld Steel Co.
206	Union Carbide Corp. (Electro Metallurgical Co. Div., Haynes Stellite Co. Div., Union Carbide Plastics Co. Div.)
211	Hunter Spring Co.
215	General Electric Co.
217	Morse Chain Co.
218	Meehanite Metal Corp.
221	Roller Bearing Co. of America
227	Dobeckmun Co., Div. Dow Chemical Co.
231	*Materials in Design Engineering* (Reinhold Publishing Co.)

Magnetic Clutch

Stationary-field design, which eliminates brushes and slip rings, provides maintenance-free operation. Airgap adjustments are unnecessary because of steel laminations. Clutch has high torque-to-size ratio. *I-T-E Circuit Breaker Co.—Booth* 81.

Circle 732 on Yellow Card

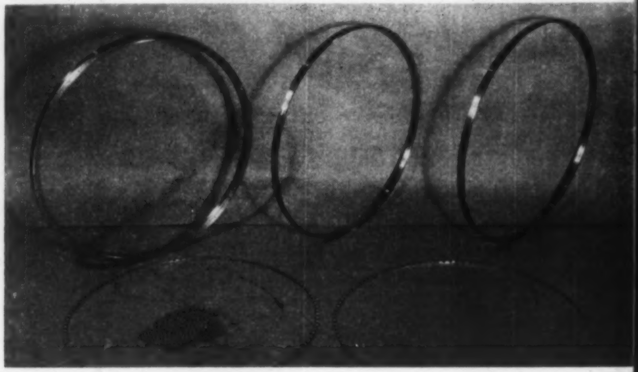




Lightweight, Compact Motor

Thinline motor is up to 55 per cent shorter and 26 lb lighter than standard NEMA type D flange motors of the same rating. It meets NEMA design B specifications for torques and starting current, and standard NEMA frame diameters are maintained. For either horizontal or vertical mounting, motor is available in polyphase dripproof and enclosed types rated 1 to 5 hp at 1800 rpm. *General Electric Co.—Booth* 215.

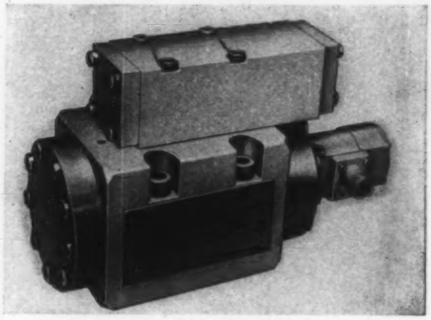
Circle 731 on Yellow Card



Precision Bearings

Small cross-section bearings—from 1/4 to 1 in.—range from 2 to 16 in. ID and 2.5 to 16.5 in. OD in the 1/4-in. size to 4 to 60 in. ID and 6 to 62 in. OD in the 1-in. size. In addition to ball bearings shown, these Featherweights are also available as roller bearings. *Messinger Bearings Inc.—Booth* 121.

Circle 733 on Yellow Card



Servo-Valve

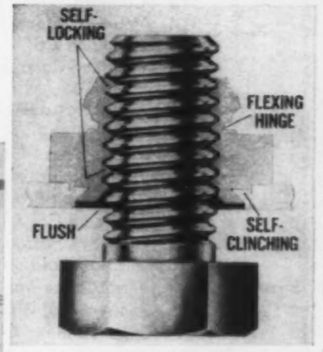
High-frequency response and reliability are features of this electrohydraulic valve, which operates at 0 to 5 gpm at 1000 psi pressure drop; supply pressure is 200 to 3000 psi. Input power is 1 w; coil resistance, 100 to 3000 ohms. Valve measures 8⅜ x 3¼ x 5⅛ in.; weighs 7.5 lb. *Sanders Associates Inc.—Booth* 88.

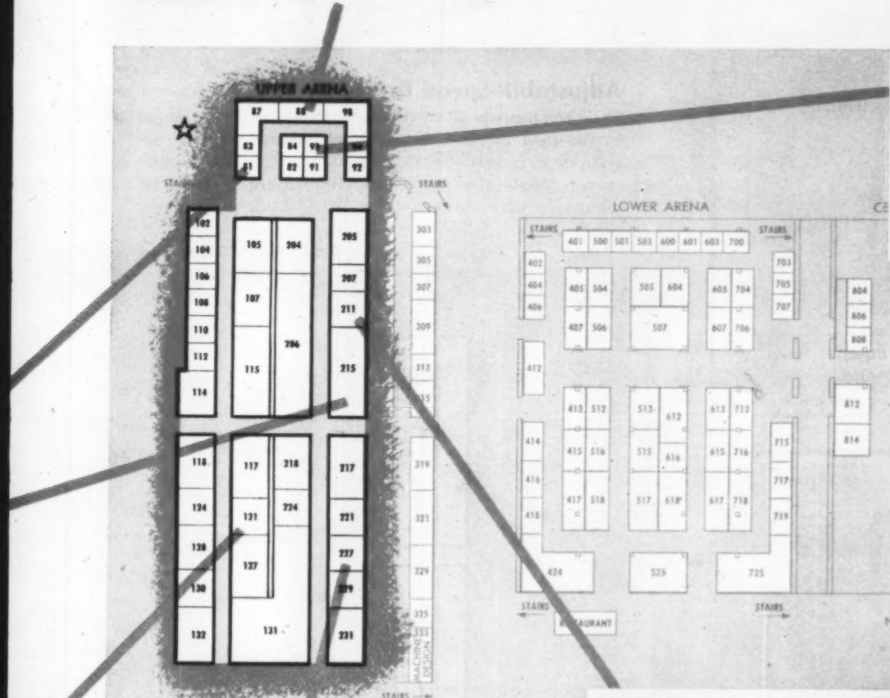
Circle 734 on Yellow Card

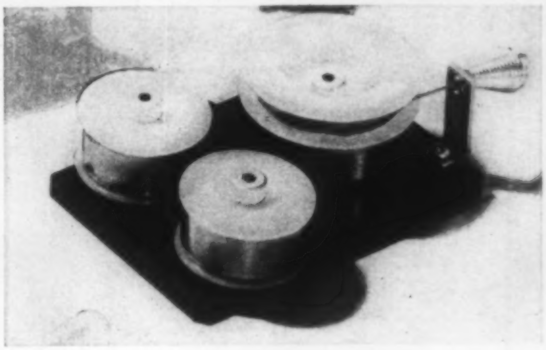
Self-Clinching Lock Nut

Torque many times the screw torque and high pull-out resistance are provided by this PEM sheet metal fastener. Locking is accomplished by squeezing—the clinching ring causes the sheet metal to flow around a back-tapered shank. *Penn Engineering & Mfg. Co.—Booth* 93.

Circle 735 on Yellow Card







Metallic Foil Flake

Six colors of 0.0008-in. thick foil are cut in various shapes from 1/64 to ¼-in. squares to 3/16-in. stars and random-cut pieces. Metalflake can be mixed with plastic pellets prior to molding, casting, or extruding to provide a decorative material. *Dobeckmun Co. Div., Dow Chemical Co.—Booth* 227. **Circle 736 on Yellow Card**

Damping Material

High damping efficiency at moderately high temperatures is provided by Armstrong's No. 881-658FF. Uses include reduction of noise from heavy-duty gearboxes and reduction of aircraft fuselage vibration. *Armstrong Cork Co.—Booth* 117.

Circle 737 on Yellow Card

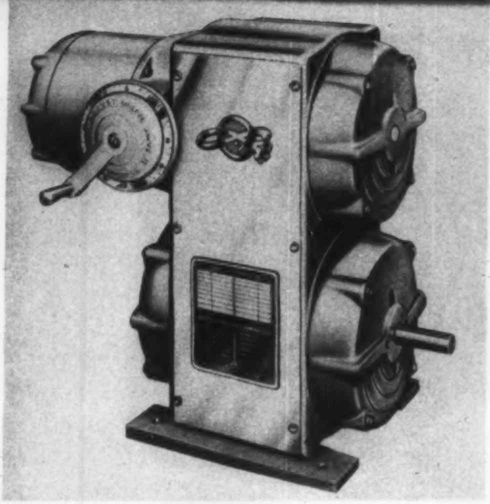
Spring Motor

Two springs instead of the usual one in Neg'ator motors increase load capacity. Motor is for experimental design work or for applications requiring relatively light constant counterbalancing or retracting forces applied through a long travel. *Hunter Spring Co.—Booth* 211.

Circle 738 on Yellow Card

★EXHIBITORS

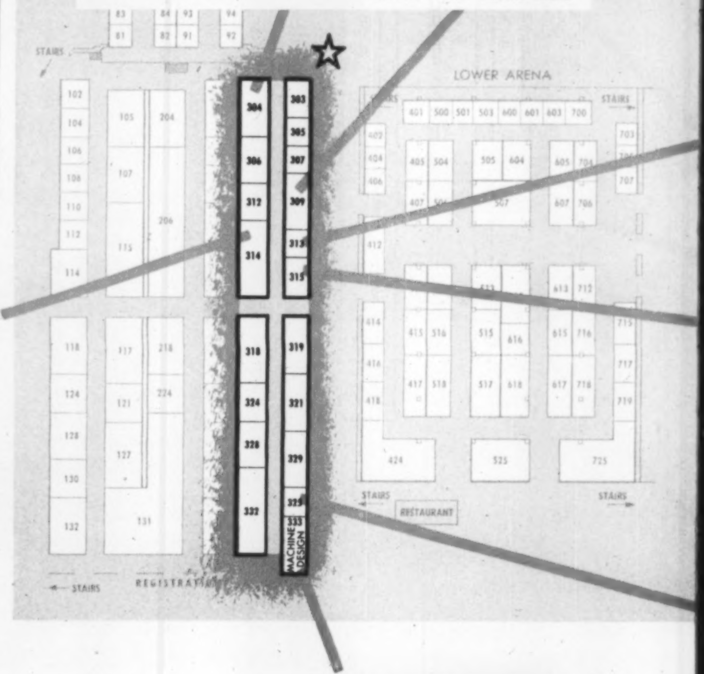
303	Cerro de Pasco Sales Corp.
304	Louis Allis Co.
305	M. H. Rhodes Inc.
307	Toyad Corp.
309	Elastic Stop Nut Corp. of America
312	Groov-Pin Corp.
313	Cullman Wheel Co.
314	Warner Electric Brake & Clutch Co.
315	Polymer Corp. of Pennsylvania
318	Metal Powder Industries Federation
319	Foote Bros. Gear and Machine Corp.
321	Tinnerman Products Inc.
324	Heli-Coil Corp.
325	Simmons Fastener Corp.
328	*Aircraft and Missiles Manufacturing, Automotive Industries, Iron Age* (Chilton Co.)
329	Rohm & Haas Co.
332	La Salle Steel Co.
333	MACHINE DESIGN, *Steel, Automation, Foundry, New Equipment Digest* (Penton Publishing Co.)



Adjustable-Speed Drive

Basic components of an Allispede drive can be rearranged in the field to meet changing requirements. For ac operation, it is available in ratings from 1 to 20 hp with output speeds of 1 to 10,000 rpm. Speed is infinitely adjustable over ranges up to 8:1. *Louis Allis Co.—Booth* 304.

Circle 740 on Yellow Card


STAIRS
LOWER ARENA
STAIRS
303
304
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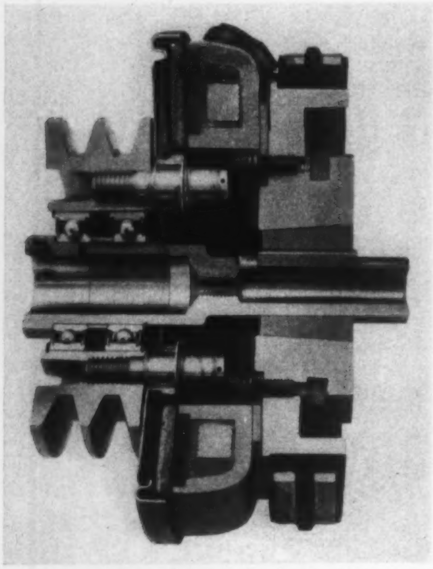
333
MACHINE DESIGN
STAIRS
RESTAURANT
STAIRS
STAIRS
REGISTRATION



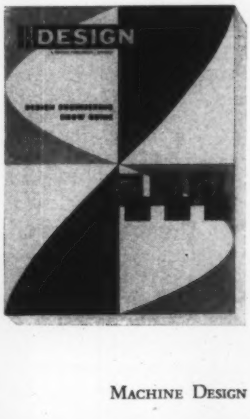
Electric Clutch-Pulley

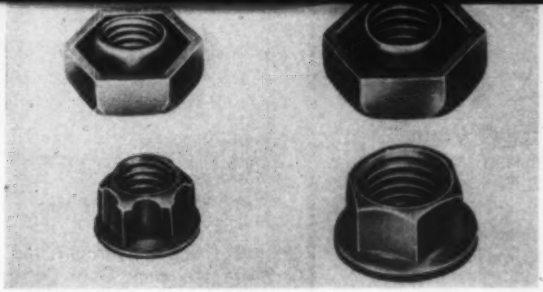
Built to fit all standard NEMA motors, Electro-Sheave engages or releases at any speed; for inching or jogging, several starts are possible in less than one revolution of the clutch. Five sizes of standard clutch units are rated from 1 to 25 hp. *Warner Electric Brake & Clutch Co.—Booth* 314.

Circle 739 on Yellow Card

Machine Design

Stop and meet the editors and other personnel in attendance, examine our latest "products," ask questions, or just rest. *Booth* 333.





Lightweight Lock Nuts

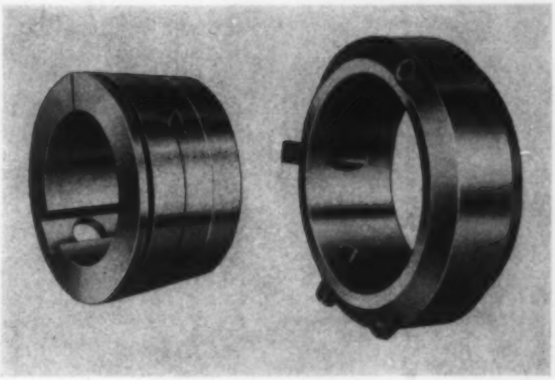
Design incorporates "minimized hex" body section, with a base ring to assure good thread load distribution and to provide adequate bearing area for use even with soft metals such as aluminum. High strength and 40 per cent weight reduction over current NAS types make the nuts suitable for aircraft and missile use. Two series, for temperatures up to 550 to 900 F, are available in sizes 4-40 through ⅜ in.-24. *Elastic Stop Nut Corp. of America—Booth* 309.

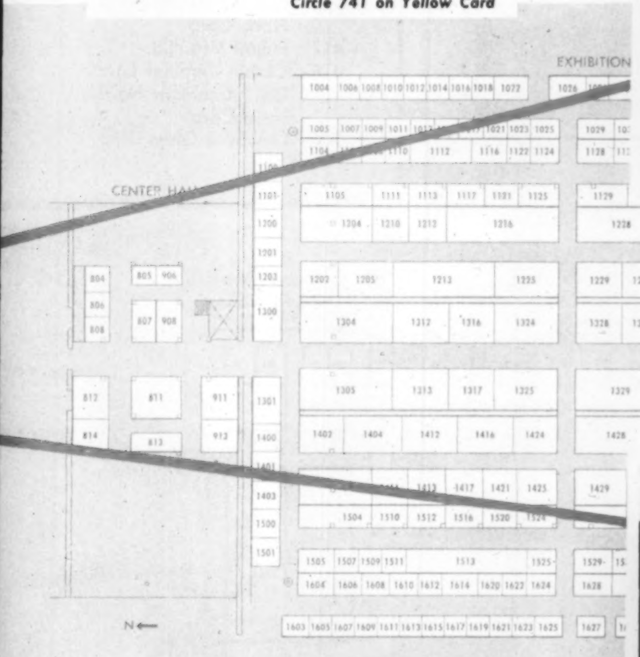
Circle 741 on Yellow Card

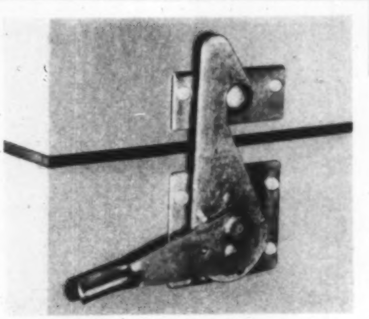
Steel Hub

Applications are for assembly of equipment such as sprockets, pulleys, sheaves, gears, and couplings. Weld-on-Hub adapts to various shaft assemblies without increasing over-all product length. No special tools are needed for installation when the Weld-on-Hub is used with the companion unit—a steel split tapered bushing. *Cullman Wheel Co.—Booth* 313.

Circle 742 on Yellow Card



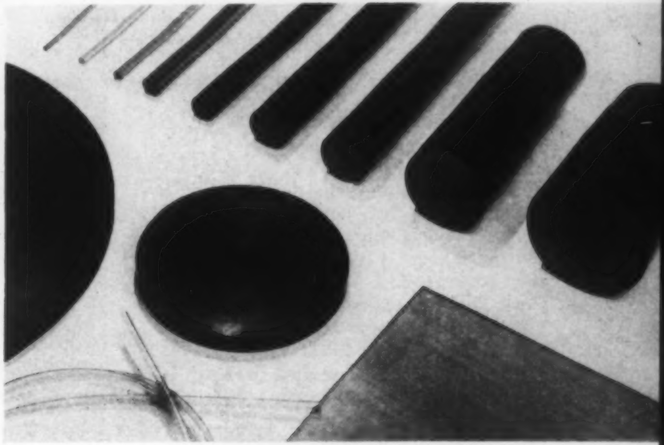




Container Latch

Remaining flat whether it is open or closed, Hook-Lock extends only 7/16 in. at its thickest point. It is positive locking without springs; load-carrying capacity of standard model is 750 lb. *Simmons Fastener Corp.—Booth* 325.

Circle 743 on Yellow Card



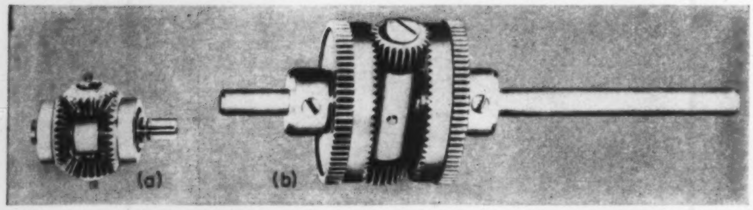
Polycarbonate Shapes

Tubing, rod from ½ to 4 in. diam, plate ¼ to 1½ in. thick, and discs 6 to 18 in. in diam and ¼ to 2 in. thick are fabricated from GE's Lexan. The thermoplastic has high impact strength, superior heat resistance, high dimensional stability, and good electrical properties. *Polymer Corp. of Pennsylvania—Booth* 315.

Circle 744 on Yellow Card

★EXHIBITORS

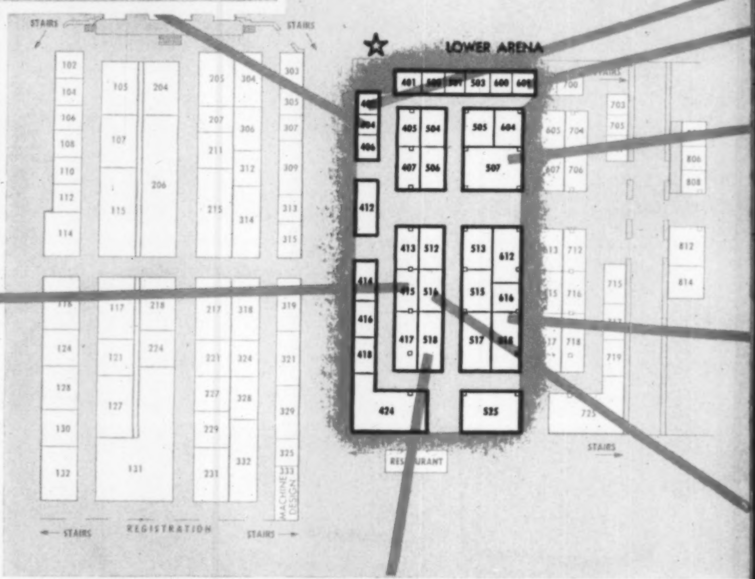
401	Chicago-Allis Mfg. Corp.
402	Roper Hydraulics Inc.
404	Dynamic Gear Co. Inc.
406	*Applied Hydraulics & Pneumatics, Power Transmission Design, Precision Metal Molding* (Industrial Publishing Corp.)
407	Web Controls Corp.
412	Copper & Brass Research Association
413	Waldes-Kohinoor Inc.
414	Titeflex Inc.
415	Synthane Corp.
416	Continental-Diamond Fibre Corp.
417	Pheoll Mfg. Co.
418	Corbin Cabinet Lock Div., American Hardware Corp.
500	Lancaster Glass Corp.



Miniature Differentials

Hollow shaft type, *a*, is available in stainless steel in shaft sizes of 1/16 and ⅛ in. Clearance diameters are 0.580 and 0.790 in. Face-gear differentials, *b*, are aluminum, bronze, or stainless steel, with clearance diameters of 0.875 in. Shaft diameters are 0.125 and 0.1875 in. Both types meet Class I or II tolerances. *Dynamic Gear Co. Inc.—Booth* 404.

Circle 745 on Yellow Card

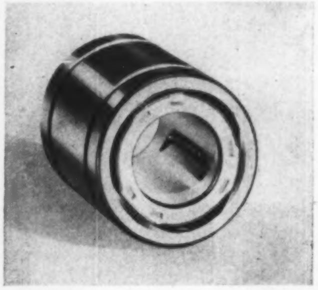


Laminated Plastics

Three paper-base types are flame retardant. Grade FR-2, furnished plain or copper-clad in sheets or strips, has a resin binder, is self-extinguishing, and possesses high arc resistance. Grade FR-1, also self-extinguishing, has high dielectric strength and resistance to moisture. Grade EP-22 has an alpha-paper filler impregnated with epoxy resin; characteristics are very low cold flow, high flexural and impact strength, and economy. *Synthane Corp.—Booth* 415.

Circle 746 on Yellow Card

Miniature Ball Bushings



Linear bushings fit shafts 0.1246 and 0.1871 in. diam. Corresponding dimensions are 0.3125 OD and 0.5 in. long and 0.375 OD and 0.562 in. long. Outer sleeve and balls are stainless steel, and ball retainer is brass. An alternate material is 52100 chrome bearing steel. *Thomson Industries Inc.—Booth* 518.

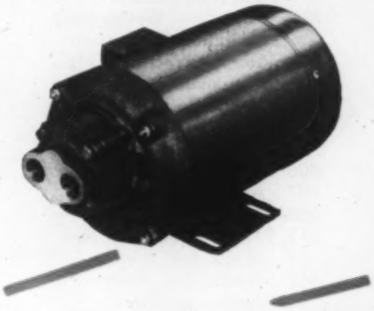
Circle 747 on Yellow Card

501	Diamond Chain Co. Inc.
503	Glass Laboratories Inc.
504	Industrial Tectonics Inc.
505	Dzus Fastener Co. Inc.
506	Fromson Orban Co. Inc.
507	Hamilton Mfg. Co.
512	L-O-F Glass Fibers Co.
513	Cleveland Worm & Gear Co., Farval Corp.
515	AMP Inc.
516	Mobay Chemical Co.
517	Corning Glass Works
518	Thomson Industries Inc
525	Republic Steel Corp.
600	G. H. Leland Inc.
601	Cherry Electrical Products Corp.
604	Sandusky Foundry & Machine Co.
612	Kaiser Aluminum & Chemical Corp.
616	International Business Machines Corp.
618	SKF Industries Inc.

Rotary Pump

Compact integral pump and motor units for hydraulic, pressure-feed, and transfer work deliver 0.3 to 55 gpm at rated maximum pressures. They have standard NEMA foot mountings. *Roper Hydraulics Inc.—Booth* 402.

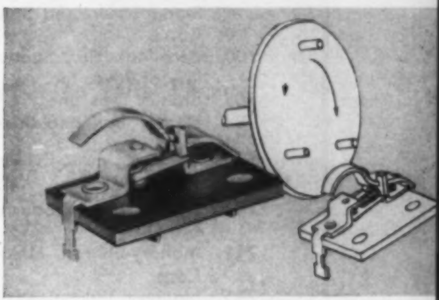
Circle 748 on Yellow Card

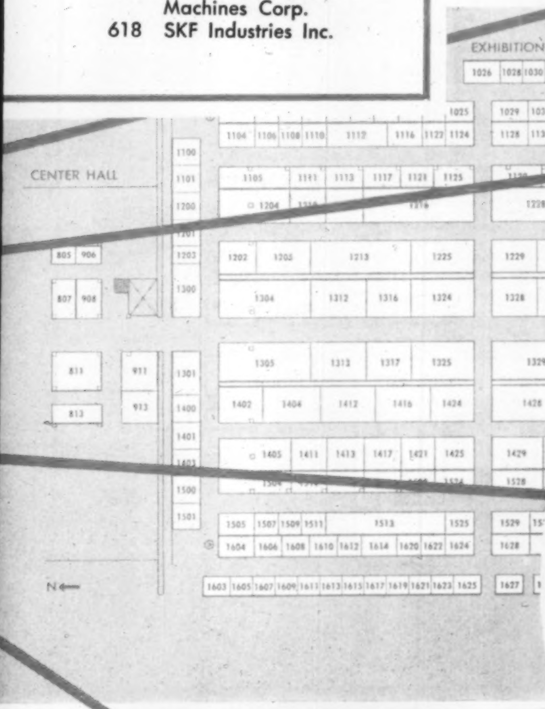


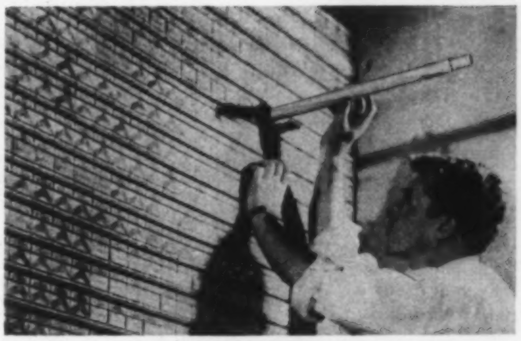
Snap-Action Switch

Actuator design permits linear cam, rotary and rotary-pin actuation. Switch accepts either clockwise or counterclockwise cam actuation. Operating force is variable from 2 to 7 oz. Ratings are 10 amp, 125 v ac; 5 amp, 250 v ac; and 1/3 hp, 125/250 v ac. *Cherry Electrical Products Corp.—Booth* 601.

Circle 749 on Yellow Card



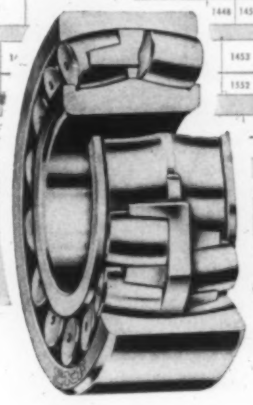




Drawing File

Modular, interlocking units are fiberboard tubes encased in square, fiberboard sheaths and capped at the ends. Labels on the doors provide for indexing and color-coding. Files are made for rolls from 22 to 54 in. long. *Hamilton Mfg. Co.—Booth* 507.

Circle 750 on Yellow Card



Urethane Elastomer

Potting and encapsulating plastics are prepared from Multrathane raw materials. Formulation with a polyester base produces high tensile strength; a polyether-based prepolymer provides a lower durometer elastomer and is more resistant to humidity aging and less expensive. *Mobay Chemical Co.—Booth* 516.

Circle 751 on Yellow Card

Screen Bearing

Spherical roller bearing meets requirements of heavy loads, high speeds, and eccentric shaft motion imposed by vibrating screens. One-piece, symmetrical cage has reamed pockets that conform closely to shape of the rollers. *SKF Industries Inc.—Booth* 618.

Circle 752 on Yellow Card

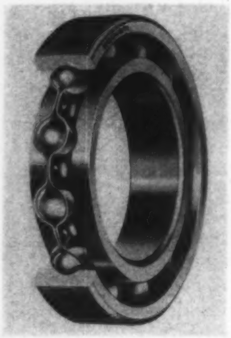
★EXHIBITORS

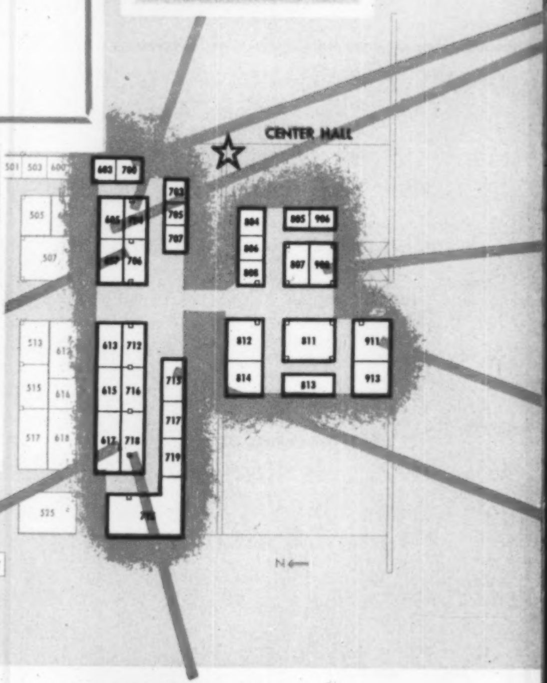
603	Coors Porcelain Co.
605	Chain Belt Co.
607	E. F. Houghton & Co.
613	Hansen Mfg. Co.
615	O'Neil-Irwin Mfg. Co.
617	Standard Pressed Steel Co.
700	Zero-Max Co., Subsidiary of Revco Inc.
703	Stahlin Bros. Inc.
704	Hoover Ball and Bearing Co.
705	Westplex Corp.
706	Huck Mfg. Co.
707	Lignum-Vitae Products Corp.
712	Mallory-Sharon Metals Corp.
715	National Vulcanized Fibre Co.
716	Formsprag Co.
717	Alemite Div., Stewart-Warner Corp.
718	Illinois Tool Works (Licon Div., Shakeproof Div., Spiroid Div.)
719	Sylvania Electric Products Inc., Parts Div.
725	Canadian Government Exhibition Commission
804	Sterling Precision Corp., Instrument Div.
805	MM Enclosures Inc., Affiliated with A & P Metal Products Mfg. Corp.
806	Shwayder Bros. Inc.
807	Acme Steel Co.
808	Artus Corp.
811, 912	International Nickel Co. Inc.
812	Ozalid Div., General Aniline & Film Corp.
813	Battelle Memorial Institute
908	Heim Co.
911	Browning Mfg. Co.

Lightweight Bearing

Reduced width and outside diameter of 3L00 extra-light bearing recommends it for applications requiring maximum shaft diameter and minimum housing area. Dimensions are substantially smaller than standard light, medium, or heavy bearings of comparable shaft sizes. Bearings are for shaft sizes of 17 to 65 mm. *Hoover Ball & Bearing Co.—Booth* 704.

Circle 756 on Yellow Card

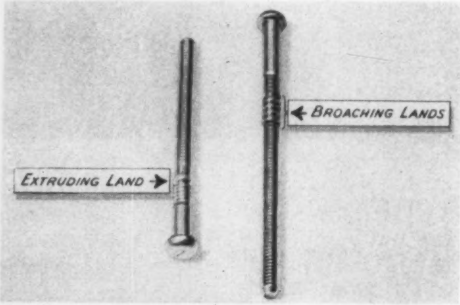


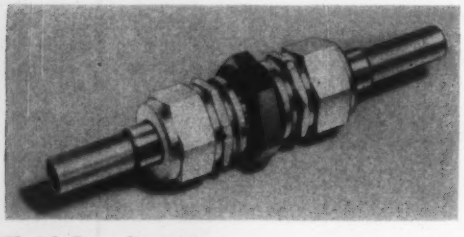


Hole-Sizing Fasteners

Extruding land and broaching lands in Huckbolt fasteners size drilled holes to precise dimensional tolerances during installation. *Huck Mfg. Co. — Booth* 706.

Circle 753 on Yellow Card





Fluid-Coupling Nut

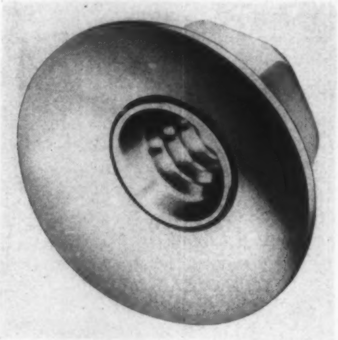
Self-locking fastener for hydraulic lines subject to vibration eliminates need for wiring to prevent loosening and leakage. CN-8 series nut can be reused more than 15 times without impairing locking. *Standard Pressed Steel Co.—Booth* 617.

Circle 754 on Yellow Card

Nut-and-Washer Assembly

Dished, conical-washer Keps spans large-clearance holes, providing washer and nut in one piece. Sizes range from No. 8 to 5/16 in., with various washer sizes. *Shakeproof Div., Illinois Tool Works—Booth* 718.

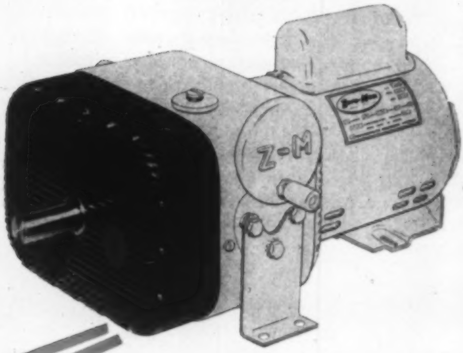
Circle 755 on Yellow Card



Geared Speed Control

Two-step gearheads either multiply speed range of Zero-Max infinitely variable speed controls up to five times or reduce torque up to four and one-half times. Speed range is 0 to 2000 rpm; torque limit is 450 lb-in. Gearheads are available in eight ratios including 2:1, 3:1, 4:1, or 5:1 and 1:2, 1:3, 1:4, or 1:5. *Revco Inc.—Booth* 700.

Circle 757 on Yellow Card



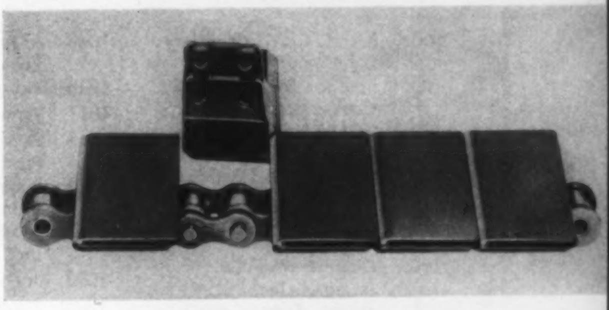
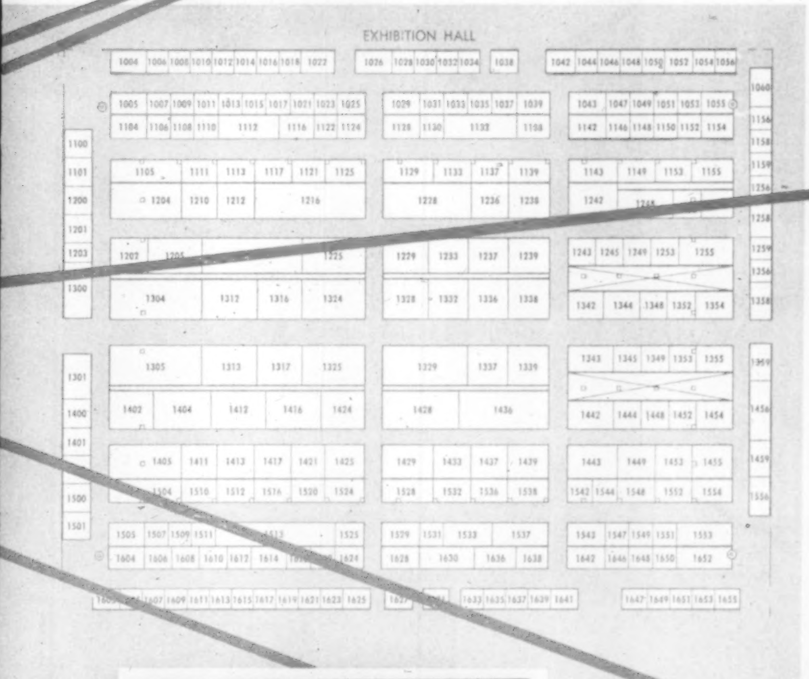
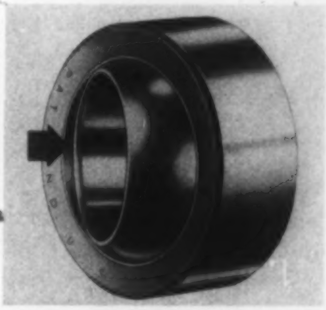


Plate-Top Roller Chain

Nylon top plates snap onto extended pins of Rex A.S.A. roller chain components to provide smooth operation for flat-top conveying applications. *Chain Belt Co.—Booth* 605.

Circle 758 on Yellow Card





Low-Friction Bearing

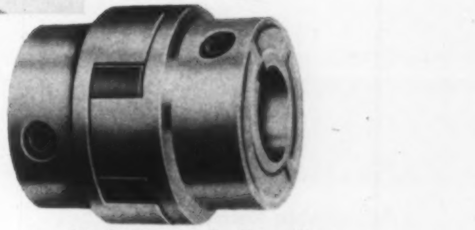
Bonded to the outer member of this spherical bearing, a layer of woven Du Pont Teflon provides a long-wearing, low-friction, self-lubricating bearing surface. Bearing can be used at temperatures up to 500 F. *Heim Co.—Booth* 908.

Circle 759 on Yellow Card

Flame-Retardant Materials

Pyronil, a vulcanized fiber, can be formed easily, fabricated, and scored. Applications are for flame and heat barriers in electronic equipment. Three grades of Phenolite for printed circuitry are: EP-491, an epoxy paper-base material with excellent electrical properties; GB-890, a Teflon-bonded glass fabric laminate with high heat resistance and low water absorption; and XXXP-475, an economical modified phenolic paper-base grade with excellent flame-retardant characteristics. *National Vulcanized Fibre Co.—Booth* 715.

Circle 760 on Yellow Card



High-Strength Coupling

Made of malleable iron, fixed bore or bushed jaw coupling is "unbreakable." Fixed-bore type has standard keyseats and hollow-head setscrews. *Browning Mfg. Co.—Booth* 911.

Circle 761 on Yellow Card

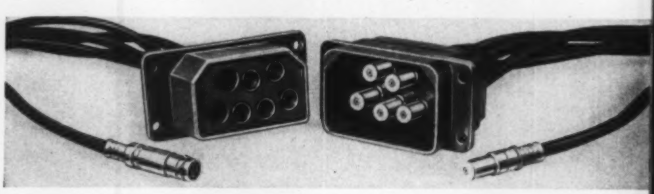
★EXHIBITORS

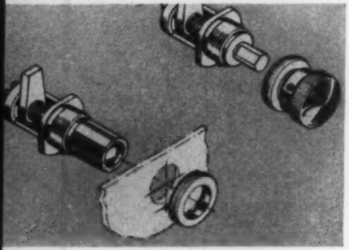
1004	Burndy Corp., Omaton Div.
1005	Southco Div., South Chester Corp.
1006	United States Plywood Corp.
1007	Hartford Steel Ball Co. Inc.
1008	Farley & Loetscher Mfg. Co.
1009	Circle F Mfg. Co.
1010	Research Inc.
1011	A. W. Faber-Castell Pencil Co. Inc.
1012	Ebert Electronics Corp.
1013	Pressco Casting & Mfg. Corp.
1014	Thomas & Betts Co. Inc.
1015	Arguto Oilless Bearing Co.
1016	Industrial Press
1017	Permacel-LePage's Inc.
1018	Buchanan Electrical Products Corp.
1021	Bunting Brass and Bronze Co.
1022	Laminated Shim Co. Inc.
1023	John Waldron Corp.
1025	Simplatrol Products Corp.
1026	Carr Fastener Co., Div. United-Carr Fastener Corp.
1028	Gordos Corp.
1029	Taylor Fibre Co.

Snap-Lock Coaxial Connector

Crimp-type, snap-locked solderless Hyfen type ME7X-1 connects coaxial cable. Crimped connection provides a measurable quality control for each connection. Plug and receptacle can be used as a gang connect or disconnect, or each contact can be inserted, removed, and reinserted as needed. *Burndy Corp.—Booth* 1004.

Circle 763 on Yellow Card

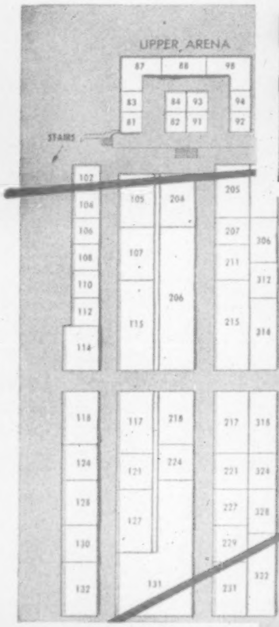


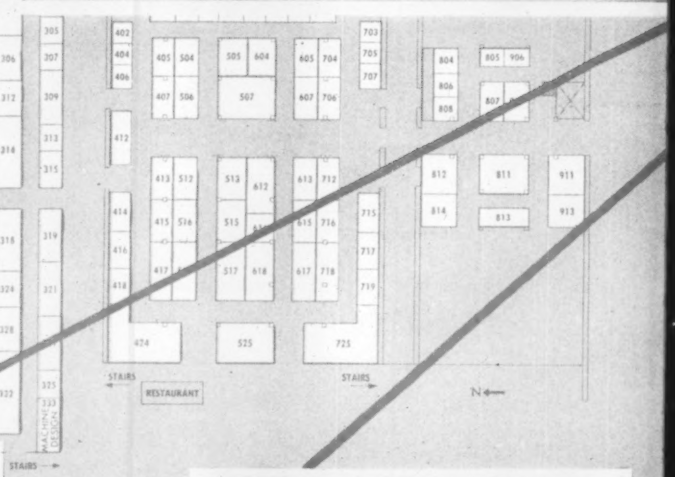


Quick-Installation Pawl Fastener

Two holes, for the fastener shaft and for a stop pin which prevents rotation, hold the No. 48 miniature pawl fastener in place without rivets or bolts. It adjusts its pawl position to accommodate variations in frame thickness up to ¼ in. *Southco Div., South Chester Corp.—Booth* 1005.

Circle 762 on Yellow Card



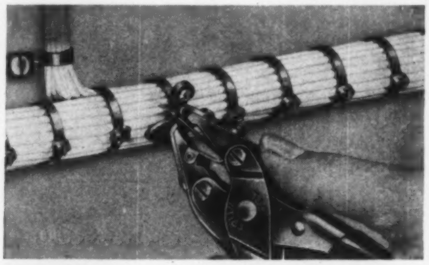


Micrelay
EBERT ELECTRONICS CORP.

Adjustable Relay

Dial-adjustable to any degree of signal sensitivity from 100,000 to 20 megohms input impedance, Model B electronic sensitive Micrelay controls up to 60-amp loads from a 2-microamp source. *Ebert Electronics Corp.—Booth* 1012.

Circle 764 on Yellow Card



Cable Tie

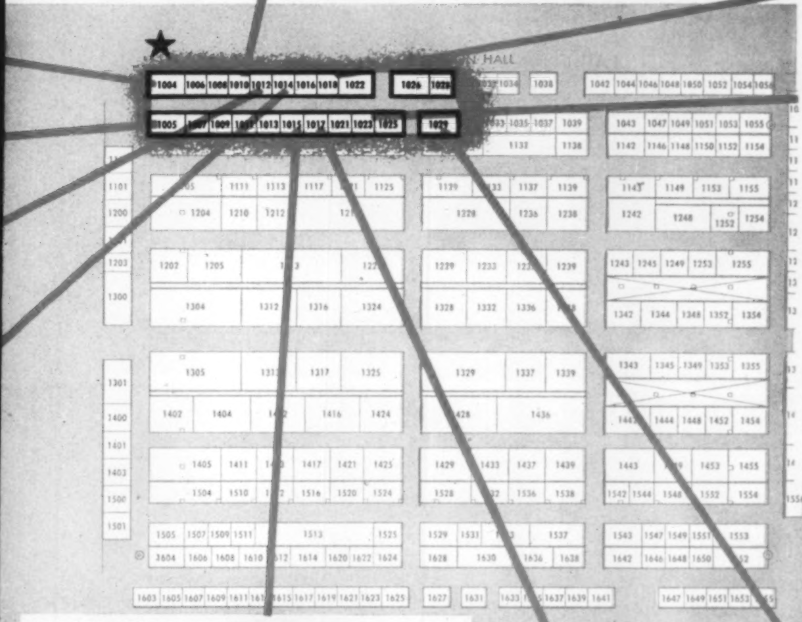
Installation of molded nylon Ty-Rap takes less than 5 seconds. Tie weighs about 1/35 oz, requires over 60-lb force to break grip, and can be used at temperatures from −65 to 350 F. *Thomas & Betts Co. Inc.—Booth* 1014.

Circle 765 on Yellow Card

Function Generator

Data-Trak translates plotted data to an equivalent electrical time-varying signal. Graph paper is attached to the outer surface of the rotating function generator drum; speed of drum's rotation establishes the time scale, while the ordinate of the curve is translated to a corresponding shaft rotation by a noncontacting, servo-driven line follower system. *Research Inc.—Booth* 1010.

Circle 766 on Yellow Card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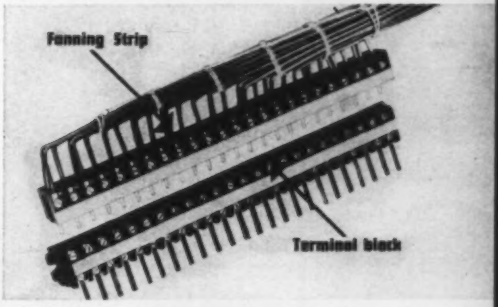
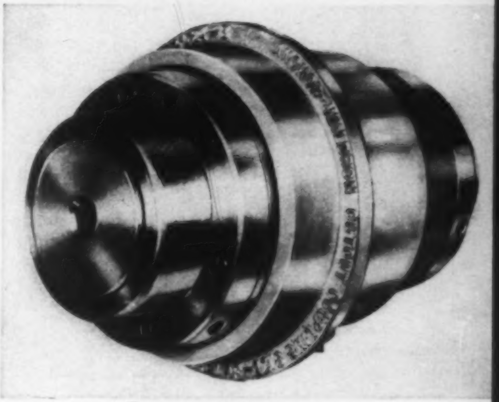
Wire-Fanning Strips

Quick, orderly connection or disconnection of a group of circuits is made possible by fanning strips. Strips are for use with Buchanan terminal blocks having tubular type contacts. *Buchanan Electrical Products Corp.—Booth* 1018.

Circle 767 on Yellow Card

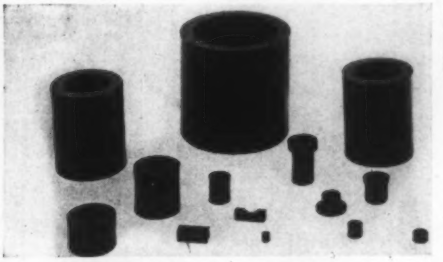

Fanning Strip
Terminal block



Torque-Sensitive Coupling

Combination gear coupling and cut-out provides overload protection, increased misalignment capacity, and ease of maintenance. Power is shut off instantly when dangerous overload occurs. Coupling compensates for slight parallel misalignment, angular misalignment, or a combination of both. *John Waldron Corp.—Booth* 1023.

Circle 768 on Yellow Card



Plastic-Alloy Bearings

Oilless bearings for −250 to 375 F application are made of material which can be molded to any shape, is machinable to close tolerances, and will not cold flow or melt. One ingredient acts as a lubricant reservoir, dispersing and reabsorbing lubricant; another ingredient dissipates heat through bearing wall to housing. *Arguto Oilless Bearing Co.—Booth* 1015.

Circle 769 on Yellow Card

Roll Type Thread Sealant

Ribbon dope comes in 260 and 520-in. lengths, each roll in an individual dispenser box. Shelf life is unlimited. Sealant protects pipe points from corrosion. It can be used at temperatures from −250 to 500 F. *Permacel—Booth* 1017.

Circle 770 on Yellow Card

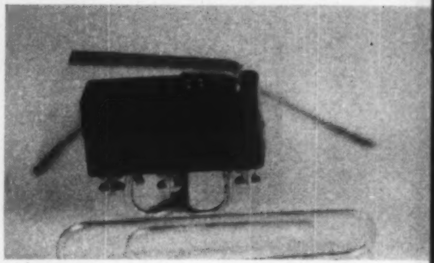
Copper-Laminate Finish

New finish on copper-clad laminates assures uniform coverage by all types of acid-resist inks without further surface preparation. Altori finish, which was adopted primarily to improve printability of rolled copper, improves solderability as well, reduces number of rejects in production of printed circuits, and assures reliable performance. *Taylor Fibre Co.—Booth* 1029.

Circle 771 on Yellow Card

★EXHIBITORS

1030	Acro Div., Robertshaw-Fulton Controls Co.
1031	Metron Instrument Co.
1032	Palnut Co.
1033	Plan Hold Corp.
1034	Rosan Inc.
1035	Panduit Co.
1037	New England Laminates Co. Inc.
1038	W. H. Brady Co.
1039	Miller Electric Co.
1042	Fenwal Inc.
1043	MacLean-Fogg Lock Nut Co.
1044	Vlier Engineering Corp.
1046	Chicago Reference Book Co.
1047	H P L Mfg. Co.
1048	Glass Tempering Association
1049	Anchor Plastics Co. Inc.
1050	Wall Colmonoy Corp., Stainless Processing Div.
1051	Minneapolis-Honeywell Regulator Co.
1052	Faultless Caster Corp.
1053	Hydreco Div., New York Air Brake Co.
1054	Fairbanks, Morse & Co., Magneto Div.
1055	Commercial Filters Corp.
1060	Lehigh Chemical Co.

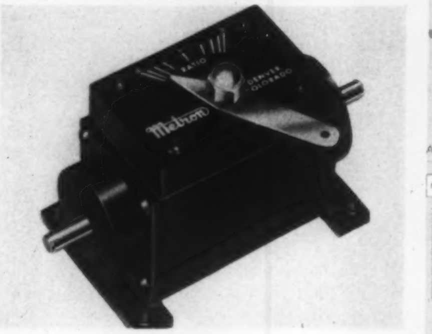


Subminiature Switch

Long-life Z switch features light operating pressure. Switch is available with free-floating, case-mounted actuator. *Robertshaw-Fulton Controls Co.—Booth* 1030.

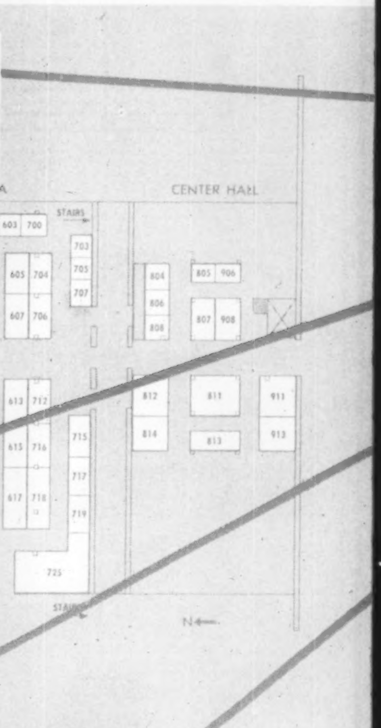
Circle 776 on Yellow Card

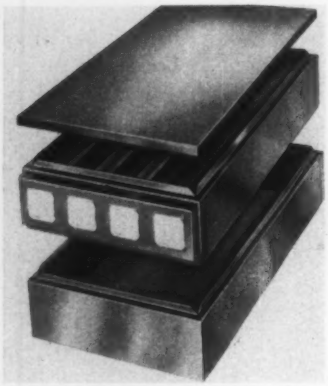
Miniature Speed Changer



Adjustable-ratio speed changer designated Series 2 is more accurate and has better repeatability and longer life than previous model. Maximum output is 0.025 hp, maximum speed, 10,000 rpm. Speed ratio is continuously variable from 1:5 up to 5:1 down (25:1 over-all range). Torque output is 5 to 40 oz-in., depending on ratio setting. *Metron Instrument Co.—Booth* 1031.

Circle 772 on Yellow Card

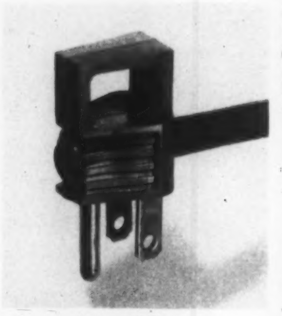




Large-Drawing File

Rolled drawings up to 60 in. long can be stored in steel stack-type file. Four 2⅝ in. diam tubes, available in lengths from 24 to 60 in. in 6-in. increments, are housed in a unit. Sections can be fastened laterally and fit on top of each other. *Plan Hold Corp.—Booth* 1033.

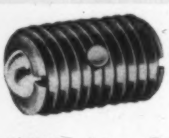
Circle 773 on Yellow Card



Three-Wire Plug

Molded of PVC on wire to specifications, plug has a flexible handle to facilitate removal from outlet. It is rated at 15 amp, 125 v and can be used for wire types SJT and 16 or 18 SPT-3. *Miller Electric Co.—Booth* 1039.

Circle 774 on Yellow Card



Self-Locking Ball Plunger

A resilient, tough Nylok pellet protruding slightly above the major thread diameter in this ball plunger keeps it positioned without secondary locking devices. Used in indexing, locating, and positioning, or as detents, ball plungers are available in six sizes with 18 end pressures. *Vlier Engineering Inc.—Booth* 1044.

Circle 775 on Yellow Card

Floating Press Nut

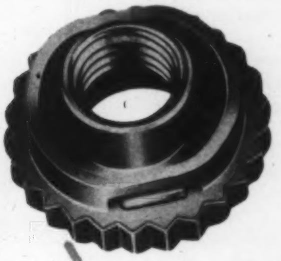
Lightweight panel fastener has 0.030 in. float within its retainer and does not require a rivet. Nut provides maximum resistance to push-out and torque-out. It is made in sizes 4 through 1/4 in. *Rosan Inc., Booth* 1034.

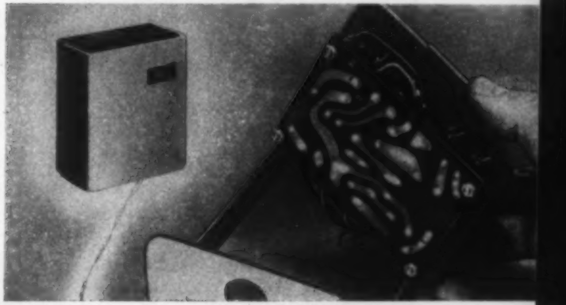
Circle 777 on Yellow Card

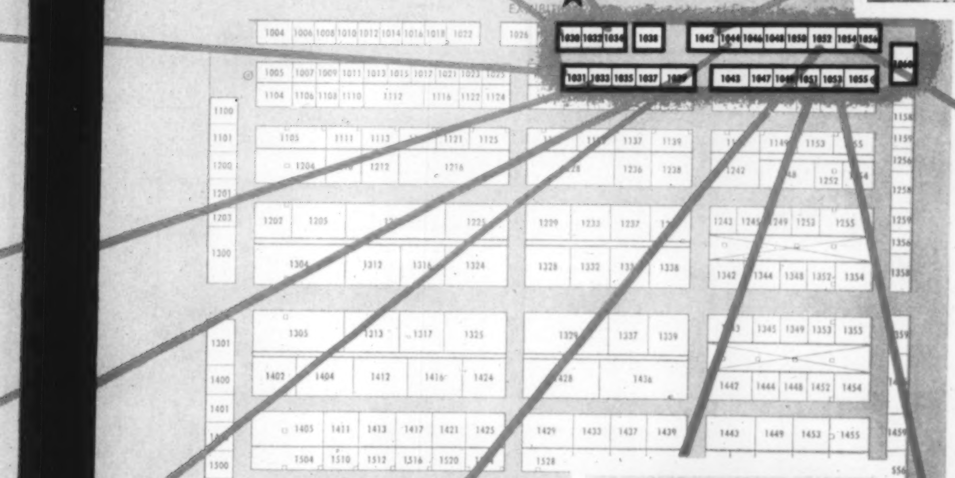
Temperature Controller

Thermistor sensing probes feed into a transistor amplifier in Model 535 temperature controller. Designed for single-point control, it covers a range of 0 to 600 F. Sensing elements can be mounted hundreds of feet from the controller, and connections can be uncompensated standard electric wiring. *Fenwal Inc.—Booth* 1042.

Circle 778 on Yellow Card



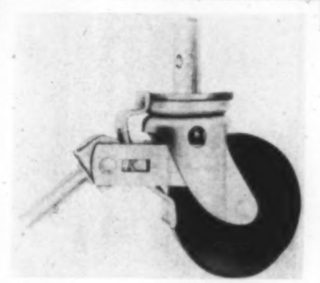




Centrifugal Clutch

Moderate camming or locking-in action permits clutch to disengage at approximately the same speed with which it engages, with or without load. It is designed for high operating speeds or medium pulsating loads. Capacities available are 1 to 30 lb-ft, for speeds of 1200 to 3600 rpm, with $4\frac{1}{4}$ in. OD and 7/16—1 in. bore. *Fairbanks-Morse & Co., Magneto Div—Booth* 1054.

Circle 779 on Yellow Card



Double-Locking Casters

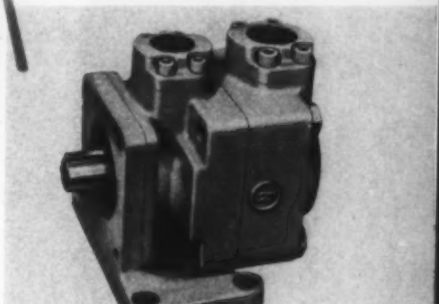
Stem-type, medium-duty casters have a simultaneous locking device that prevents both rolling and swiveling. Load capacities are 175 to 500 lb. *Faultless Caster Co.—Booth* 1052.

Circle 780 on Yellow Card

Electronic Temperature Controller

When used with the appropriate thermistors, transistorized units can control liquid and air temperatures from −60 to 500 F and surface temperatures from −60 to 200 F. Models are made for heating and/or cooling applications. *Minneapolis-Honeywell Regulator Co.—Booth* 1051.

Circle 781 on Yellow Card



Hydraulic Pump

New line of Dual Vane fluid power pumps and motors is designed for pressures up to 2000 psi and capacities to 140 gpm. *New York Air Brake Co.—Booth* 1053.

Circle 782 on Yellow Card

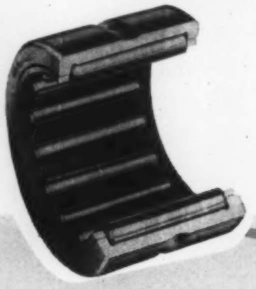
★EXHIBITORS

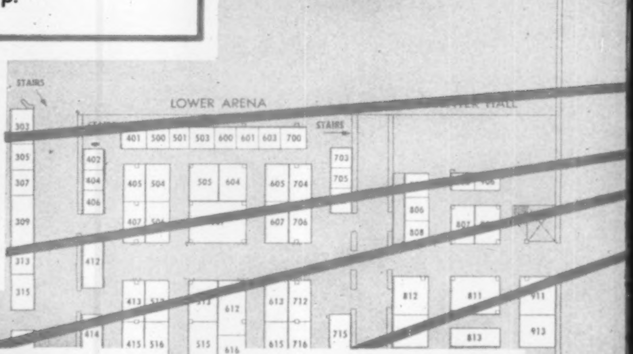
1101	Instrument Specialties Co. Inc.
1104	Janney Cylinder Co.
1105	Dodge Mfg. Corp.
1106	Star Expansion Industries Corp.
1108	Nice Ball Bearing Co.
1110	Heyman Mfg. Co.
1111	Saginaw Steering Gear Div., GMC
1112	Century Electric Co.
1113	Cleveland Graphite Bronze Co., Div. Clevite Corp.
1116	McGill Mfg. Co. Inc.
1117	T. B. Wood's Sons Co.
1121	Franklin Electric Co. Inc.
1122	John Hassall, Inc.
1124	Camloc Fastener Corp.
1125	Hoke Inc.
1128	Coating Products Inc.
1129	Lead Industries Association
1130	Valcor Engineering Corp.
1132	Aeroquip Corp.
1133	Bristol Co.
1137	Duff-Norton Co.
1138	Hilliard Corp.
1139	Stratoflex Inc.
1142	Wagner Electric Corp.
1143	Ferguson Machine Corp.
1146	Sigmamotor Inc.
1148	Penn Metal Co. Inc.
1149	Spaulding Fibre Co. Inc.
1150	Fawick Airflex Div., Fawick Corp.
1152	McCauley Industrial Corp.
1153	Landis and Gyr Inc.
1154	Graham Transmissions Inc.
1155	Flexonics Corp.
1156	Cleveland Hardfacing Inc.
1158	Manheim Mfg. & Belting Co.
1159	Dixon Corp.

Cage-Type Roller Bearing

Adequate capacity is provided by Cagerol needle-type caged roller bearing for application where excess misalignment prohibits use of higher capacity, full-complement bearings. Sizes are from 0.875 to 1.500 in. *McGill Mfg. Co. Inc., Bearing Div.—Booth* 1116.

Circle 787 on Yellow Card

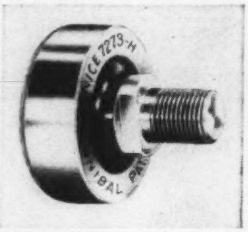




Heavy-Duty Bearing

Full-complement ball bearings for applications requiring durability and strength include Unibal plunger guide roller. Solid inner and outer raceways have deep, unbroken grooves and maximum number of balls. *Nice Ball Bearing Co.—Booth* 1108.

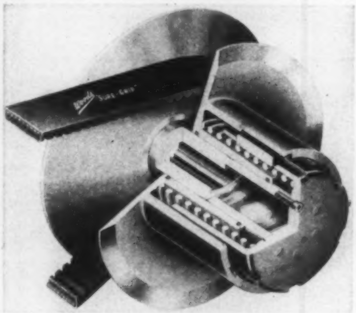
Circle 783 on Yellow Card



V-Belt Drive

Small, lightweight sheaves and high-capacity, low-cost V-belts are combined in the Dyna-V drive. Two standard groove sizes —3/8 and 5/8 in.—meet all except the largest requirements. Smaller size is for drives from 1 to 50 hp; larger size, for 1 to 200 hp. *Dodge Mfg. Corp.—Booth* 1105.

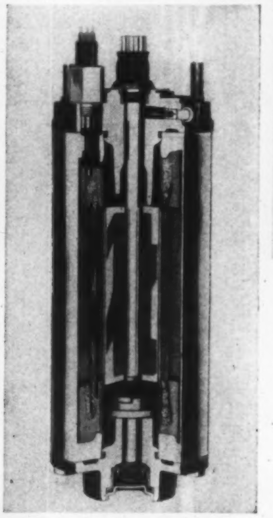
Circle 784 on Yellow Card



Variable-Speed Sheave

Fretting corrosion, as well as freezing and sticking, is eliminated in MS series pulleys. Bearing surfaces are oiled continuously from a reservoir with each rotation of the pulley. Five models are rated 2, 3, 5, 10, and 15 hp. *T. B. Wood's Sons Co.—Booth* 1117.

Circle 785 on Yellow Card



Water-Lubricated Motor

Water lubrication of Series 15-MT motor results in low friction losses and eliminates possibility of damage due to loss or dilution of lubricant. Motors are available in 1 to 20-hp ratings; well sizes are 4 and 6 in. *Franklin Electric Co.—Booth* 1121.

Circle 786 on Yellow Card

Bubble-Tight Solenoid Valve

Developed for missile applications, in-line valve will handle cryogenic fluids, ethylene oxide, jet fuels, high-pressure pneumatics, liquefied gases, and hydraulic oils at temperatures from −320 to 500 F. Pressure ratings are up to 4500 psi. *Valcor Engineering Corp.—Booth* 1130.

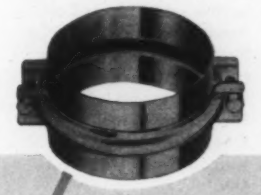
Circle 788 on Yellow Card

VALCOR
SOLENOID VALVE

Self-Aligning Tube Connector

Positive joints without special aligning are provided by V-Band tube joint. Two bolts fasten the joint; it is leakproof and highly vibration resistant. Various sizes fit 1½ to 4½ OD tubing. *Aeroquip Corp., Marman Div.—Booth* 1132.

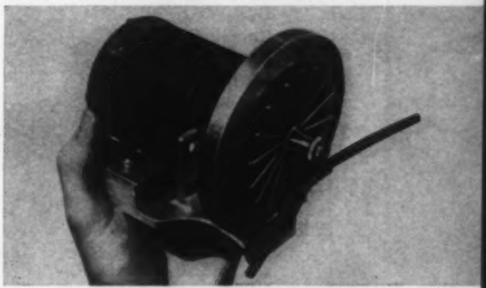
Circle 789 on Yellow Card

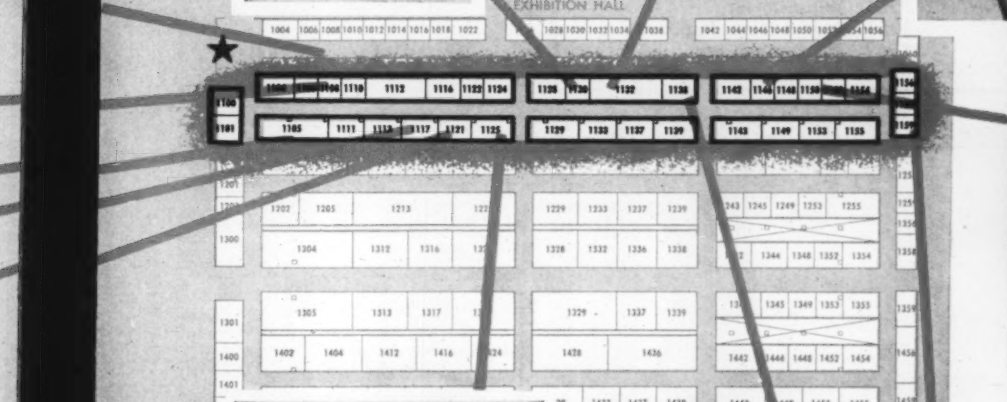


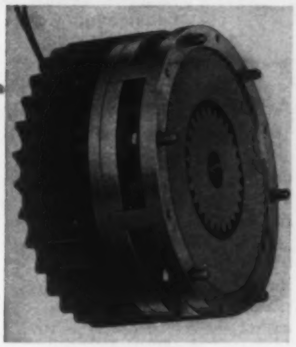
Kinetic Clamp Pump

Positive-displacement motor-driven pump operates with peristaltic action by means of progressive clamping of radial arms on wall of flexible tubing. Pressure of one arm is not released until the next arm is in clamping position. With ¼-in. tubing, maximum delivery is 110 ml per min at 192 rpm rotor. *Sigmamotor Inc.—Booth* 1146.

Circle 790 on Yellow Card




EXHIBITION HALL
1004 1006 1008 1010 1012 1014 1016 1018 1022
1028 1030 1032 1034 1038
1042 1044 1046 1048 1050 1056
1110 1112 1116 1122 1124
1128 1132 1136
1142 1146 1148 1150 1154
1100 1101
1105 1111 1117 1121 1125
1129 1133 1137 1139
1143 1149 1153 1155



Magnetic Brakes

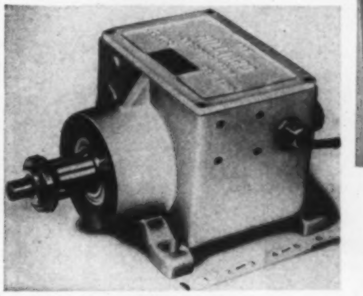
Instantaneous and positive braking is achieved by heavy-duty coil-spring engagement and electromagnetic release in SB magnetic brakes. Nine standard sizes are available with 4 to 12-in. diameters and dry torque ratings from 5 to 520 lb-ft. Standard voltage is 90 v dc. *Fawick Corp., Fawick Airflex Div.—Booth* 1150.

Circle 791 on Yellow Card

Pressure Regulator

Ballast controller in Series 920 regulator utilizes high-pressure gas to accomplish pressure reduction. It handles inlet pressures up to 6000 psi, with set delivery pressures ranging from 1 to 5000 psi. Under normal pressure variations, accuracy is ±1 per cent. *Hoke Inc.—Booth* 1125.

Circle 792 on Yellow Card



Intermittent Drive Unit

Precise intermittent motion from a constant source of rotary power is provided by unit designated I.D.U. Highly flexible control, manual, mechanical, or electrical, permits "demand" type operations in fixed or variable cycles. *Hilliard Corp.—Booth* 1138.

Circle 793 on Yellow Card

DEMONSTRATION

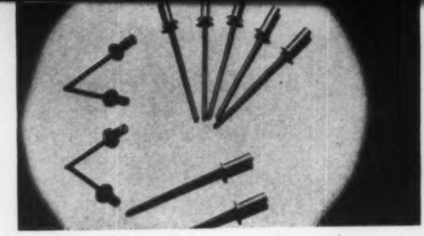
Bearing Material

Self-lubricating F-Liner bearing consists of Teflon cloth bonded to steel backing. It can be used for loads up to 2000 psi and speeds up to 40 fpm. *Dixon Corp.—Booth* 1159.

Circle 794 on Yellow Card

★ EXHIBITORS

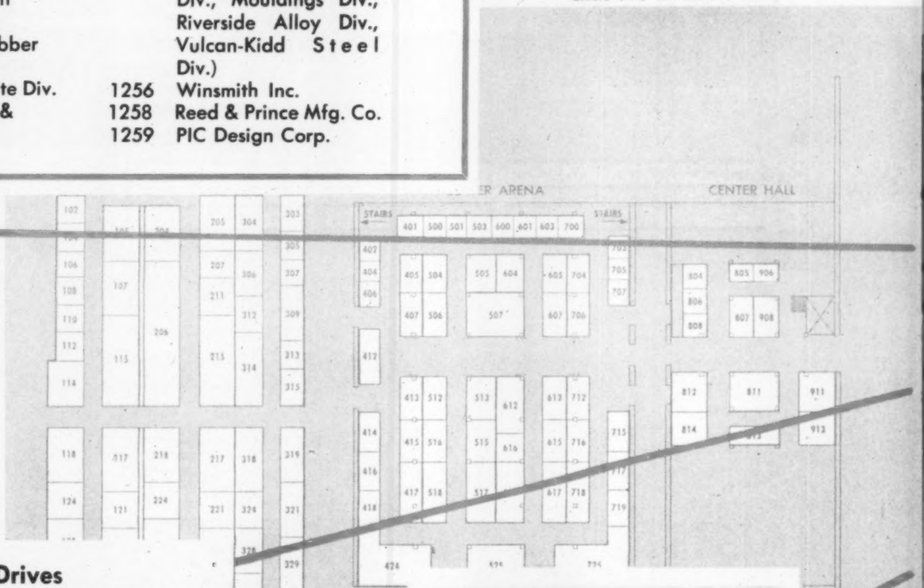
1200	Edwin L. Wiegand Co.
1201	Auburn Mfg. Co.
1202	Enjay Co., Inc.
1203	Master Etching Corp.
1204	United Shoe Machinery Corp.
1205	Delco Products Div., General Motors Corp.
1210	Bond Foundry & Machine Co.
1210	Charles Bond Co.
1212	Russell, Burdsall & Ward Bolt and Nut Co.
1213	Eastman Chemical Products Inc.
1216	U. S. Steel Corp., National Tube Div.
1225	Edwin B. Stimpson Co., Inc.
1228	United States Rubber Co., Mechanical Goods Div., Royalite Div.
1229	Reliance Electric & Engineering Co.
1233	Curtiss-Wright Corp., Metals Processing Div.
1236	Fafnir Bearing Co.
1237	Philadelphia Bronze & Brass Corp.
1238	Brook Motor Corp.
1239	C. A. Norgren Co.
1242	Anderson Co.
1243	Eastman Mfg. Co.
1245	Hydromatics Inc.
1248	C. H. Dexter & Sons Co.
1249	Flodar Corp.
1252	Southwest Products Co.
1253	Austin Screw Products Co.
1254	Stacor Equipment Co.
1255	H. K. Porter Company, Inc. (Connors Steel Div., Mouldings Div., Riverside Alloy Div., Vulcan-Kidd Steel Div.)
1256	Winsmith Inc.
1258	Reed & Prince Mfg. Co.
1259	PIC Design Corp.



Closed-End Rivet

Radial expansion of the shank is balanced with shear strength criteria to insure tightness under excessive vibration in new Pop, or Imex, rivet. It is air and water-tight at 500 psi pressures. Rivet is set by pulling a mandrel into the shank, spreading, and setting it. *United Shoe Machinery Corp.—Booth* 1204.

Circle 798 on Yellow Card



Adhesive Film

Thermal-setting, unsupported, dry adhesive film, supplied on a paper interliner, is available as preforms cut to fit shapes for bonding together. Film thickness is 0.002 in. Heat and pressure are recommended for application, but adhesive can be solvent-activated. *Auburn Mfg. Co.—Booth* 1201.

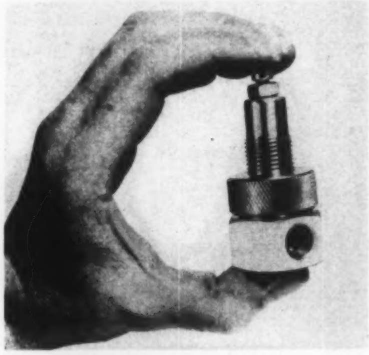
Circle 795 on Yellow Card

Fractional-Hp Electronic Drives

Rated 1/8 to 3/4-hp, fractional-horsepower V*S Jr. drives have 8:1 speed range. A single half-wave thyratron electronic tube is the main rectifier; drive operates on single-phase, 50 or 60-cycle, 220-v ac power. It is 9½ x 14 x 8¼ in. and weighs 30 lb. Control panel is built around a printed circuit board. *Reliance Electric and Engineering Co.—Booth* 1229.

Circle 796 on Yellow Card

RELIANCE
V*S
DRIVE
Jr.
ADJUSTABLE SPEED
OPERATION FROM
A-C CIRCUITS
RELIANCE
START
STOP



Small Pressure Regulators

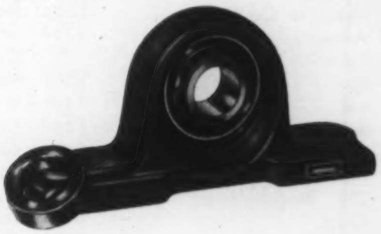
For air, water, and noncorrosive gases and liquids, 3 1/32 in. high by 1⅜ in. hex regulators are available in ⅛ and ¼ NPT pipe sizes. They handle air flows up to 20 cfm at 100 psi air pressure and can be used at maximum primary pressure of 400 psi and maximum delivery pressure of 100 psi. *C. A. Norgren Co.—Booth* 1239.

Circle 797 on Yellow Card

Relubricatable Pillow Blocks

Two series of ball-bearing pillow blocks offer improvements over previous units. Both have integral seal bearings and higher strength housing. Standard LSA series is available in sizes to 2 15/16 in.; heavy-duty LSAO series, in sizes to 3 15/16 in. *Fafnir Bearing Co.—Booth* 1236.

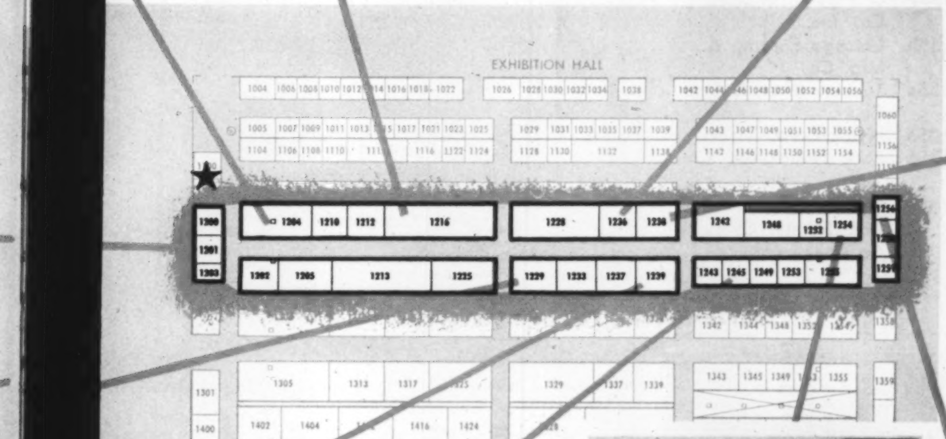
Circle 800 on Yellow Card

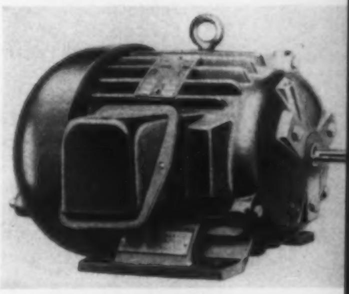


Vinyl-Coated Steel

Liquid vinyl plastisols, cured and bonded to steel sheet, can be any color and embossed with any texture that can be engraved on a printing roll. Material can be fabricated—sheared, slit, punched, lock-seamed, stamped, drawn, or roll-formed—without damage to texture or color. It can also be welded. *United States Steel Corp. —Booth* 1216.

Circle 799 on Yellow Card

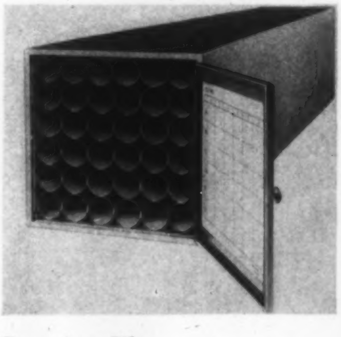




Rerated AC Motors

Smaller and more compact than standard-frame motors, NEMA rerated ac motors have same output. Weight is reduced by more than 11 per cent. *Brook Motor Corp.—Booth* 1238.

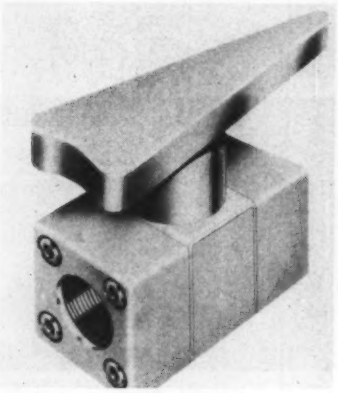
Circle 801 on Yellow Card



Drawing File

Heavy-gage steel roll file holds thirty-six $2\frac{1}{4}$ in. ID or nine $4\frac{3}{8}$ in. ID metal-rimmed tubes. Five lengths—18, 30, 36, 42, and 60 in.—are available. File opens from the front or can be stood on end to open from the top. *Stacor Equipment Co.—Booth* 1254.

Circle 803 on Yellow Card



Leakproof Valve

Flo-Ball plug valve for 3000-psi service can be used in place of a conventional needle valve in nonthrottling applications. Positive opening and shut-off are completed in one-quarter turn. *Hydromatics Inc.—Booth* 1245.

Circle 802 on Yellow Card

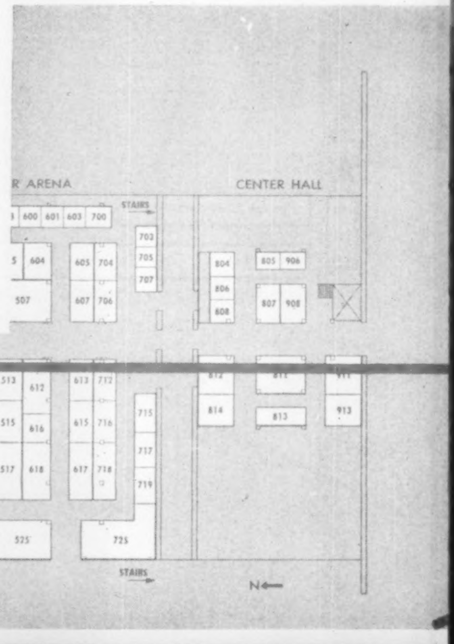
Hollow-Shaft Gear Reducer

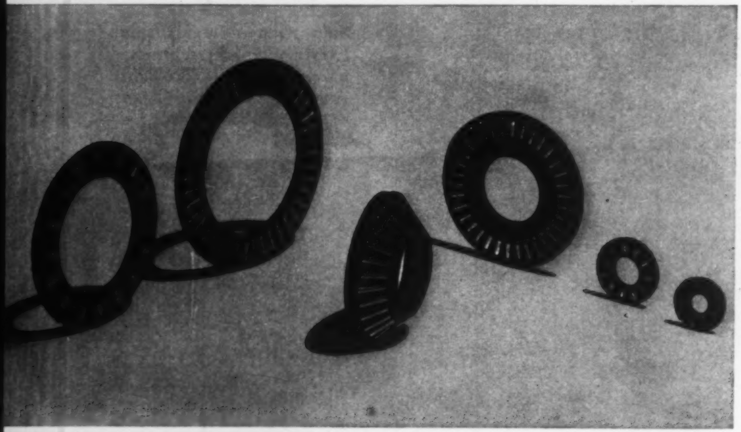
Double-reduction, hollow-shaft worm-gear speed reducer mounts directly on shaft of driven machine. Torque-arm and flange-mounted types are available in three sizes in ratios of 66 2/3:1 to 4466:1, with horsepower ranging from 0.041 to 2.252 and maximum output torque of 1378 to 7678 lb-in. Mounting requires neither couplings nor bed plates. *Winsmith Inc. —Booth* 1256.

Circle 804 on Yellow Card

★EXHIBITORS

1300	*Product Engineering*
1301	Weatherhead Co.
1304	Celanese Corp. of America
1305	Reynolds Metals Co.
1312	Revere Copper & Brass Inc.
1313	Associated Spring Corp.
1316	Marbon Chemical Div., Borg-Warner Corp.
1324	Aluminum Co. of America
1325	Kennametal Inc.
1328	International Packings Corp.
1329	Torrington Co.
1337	New Departure Div., General Motors Corp.
1338	Rogers Publishing Co.
1339	Square D Co.
1342	Colonial Rubber Co.
1342	U. S. Stoneware Co.
1342	Conneaut Rubber & Plastics Co.
1343	Marlin-Rockwell Corp.
1344	Janette Electric Mfg. Co.
1345	Vibro-Plus Products Inc.
1348	Barry Controls Inc.
1349	Cuyahoga Products Corp.
1349	Parker-Kalon Div., General American Transportation Corp.
1352	Orange Roller Bearing Co., Inc.
1353	Chicago Forging & Mfg. Co.
1354	Tubular Rivet & Stud Co.
1355	Nylok Corp.
1356	Park Nameplate Co. Inc.
1359	Skinner Electric Valve Div., Skinner Chuck Co.

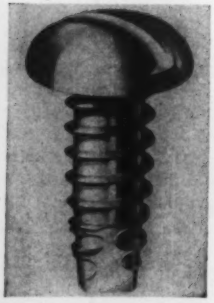

R ARENA
CENTER HALL
STAIRS
600 601 603 700
702 705 707
604 605 704
507 607 706
804 806 808
805 906
807 908
413 512 513 612 613 712
415 516 515 616 615 716
417 518 517 618 617 718
715 717 719
814 813 913
424 525 725
STAIRS
RESTAURANT
N



Plastic-Retainer Thrust Bearings

Plastic retainers for nonstandard sizes of needle thrust bearings offer economy in tooling costs. Bearings are for automotive, hydraulic, farm equipment, textile, and other applications. *Torrington Co.—Booth* 1329

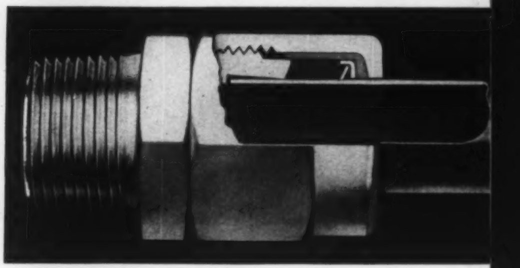
Circle 805 on Yellow Card



Thread-Cutting Screw

Developed for use in nylon, type L screw can be removed and replaced without stripping or galling. Functioning as a combination thread-cutting and thread-forming screw, it cuts a small amount of the material to allow full-diameter threads to form. *Parker-Kalon Div., General American Transportation Corp.—Booth* 1349.

Circle 806 on Yellow Card



Leakproof Tube Fitting

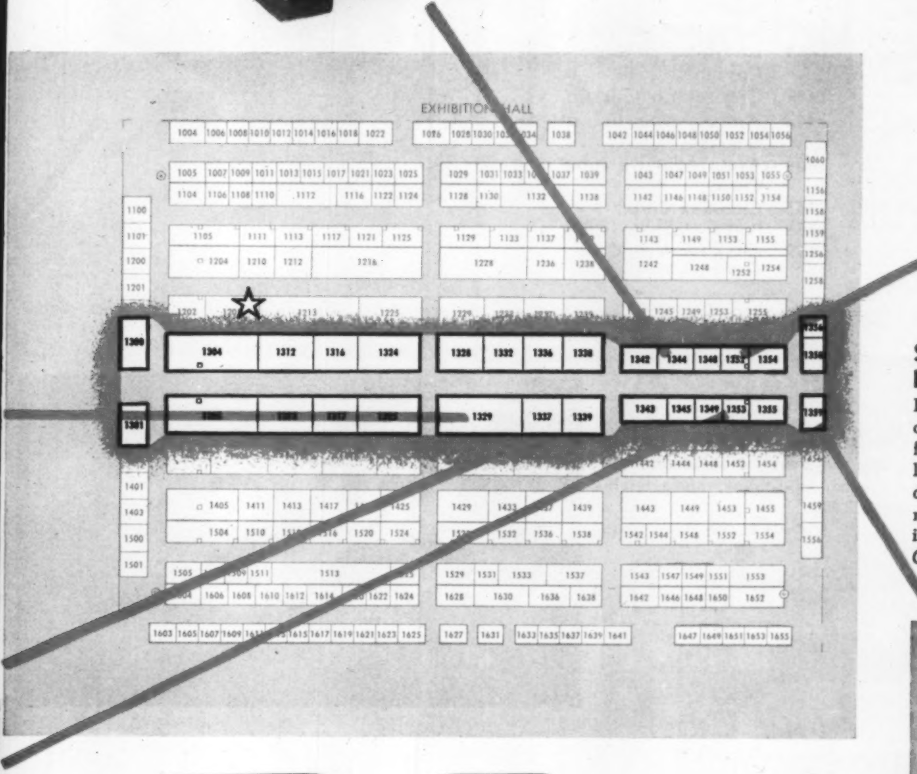
Cushion unit absorbs vibration in Rubbernek flareless fitting. Design assures leakproof joint yet permits tube movement even where tubes are misaligned due to manufacturing variables. Fitting provides a positive seal at high, medium, or low pressures in hydraulic or pneumatic systems. *Chicago Forging & Mfg. Co.—Booth* 1353.

Circle 807 on Yellow Card

Speed Reducer

Designed to accept NEMA type C face-mounted motors, speed reducer is for 1/20 through 1½-hp motors. Gear ratios are from 4:1 to 90:1, depending on horsepower. Reducer is made in three sizes. *Janette Electric Mfg. Co.—Booth 1344.*

Circle 808 on Yellow Card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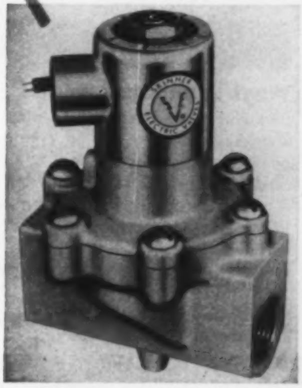
Sealed-Cage Needle Bearings

Built-in neoprene seals are offered in cage type needle bearings in 18 sizes for ½ to 2-in. shaft diameters. Two lengths are available for each shaft diameter. Addition of seals does not reduce roll length or load-carrying capacity. *Orange Roller Bearing Co. Inc.—Booth* 1352.

Circle 809 on Yellow Card



Compact Two-Way Valves

Redesigned for size and cost reduction, high-flow, two-way valves with ¾ and 1-in. orifices control air, oil, and water. They operate on a pressure differential of 5 to 150 psi. Standard and explosionproof valves are available normally open or normally closed. *Skinner Electric Valve Div., Skinner Chuck Co.—Booth* 1359.

Circle 810 on Yellow Card

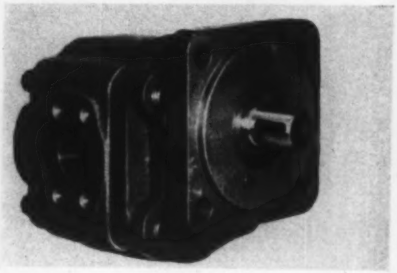
★EXHIBITORS

1400	Cuno Engineering Corp.
1401	Durakool Inc.
1402	Prudential Industries Inc.
1402	Atlas Chain & Mfg. Co.
1402	Atlas Precision Products Co.
1402	Measurements Research Co.
1403	Linemaster Switch Corp.
1405	Armco Steel Corp.
1411	Lebanon Steel Foundry
1412	Commercial Shearing and Stamping Co.
1413	Garlock Packing Co.
1416	Controls Co. of America
1417	Electric Auto-Lite Co.
1421	De Laval Steam Turbine Co.
1424	Humphrey Products Div., General Gas Light Co.
1425	General Fireproofing Co.
1428	Vickers Inc.
1429	A. Schrader's Son Div.
1433	Superior Tube Co.
1436	Link-Belt Co.
1436	Syntron Co.
1437	Columbus Coated Fabrics Corp.
1439	Universal Drafting Machine Corp.
1442	S. S. White Dental Mfg. Co.
1443	Cutler-Hammer Inc.
1448	La France Precision Casting Co.
1449	General Controls Co.
1452	Hydroforming Co. of America
1454	Avery Adhesive Label Corp.
1455	Clad-Rex Corp.
1456	Parker-Hannifin Corp.
1459	Alloy Products Corp.

Hydraulic Gear Pumps

Delivery ranging from 3 to 95 gpm for continuous-duty operation at pressures up to 2000 psi is provided by three series of fluid power gear pumps. *Commercial Shearing & Stamping Co.—Booth* 1412.

Circle 814 on Yellow Card



Identifiable Chain Link

Disassembly of a roller chain is facilitated with Identa-Link, a connecting link whose color is different from the standard black chain. Slip-fit links are copper-colored; tap-fit links are a bright steel. *Atlas Chain & Mfg. Co.—Booth* 1402.

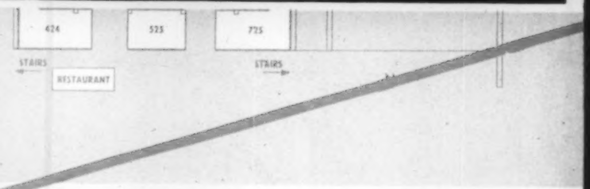
Circle 811 on Yellow Card

IDENTA LINK

Vinyl Laminates

Permanent bond of Colovin vinyl plastic to steel, aluminum, magnesium, or even wood produces a product stronger than the base material itself. It can be fabricated as precisely as plain metal and furnished in any color in variety of grains, patterns, prints, textures, and woven effects. *Columbus Coated Fabrics Corp.—Booth* 1437.

Circle 812 on Yellow Card



Dry-Bearing Thrust Washer

Washer made of DU dry bearing material has a bore diameter approximately 1/16 in. larger than journal diameter in which it is to be mounted so that the washer can be a loose fit in the housing recess. DU composite dry bearing material consists of a steel backing with a thin, sintered, porous-bronze overlay which is impregnated and thinly covered with a lead-powder-filled fluorocarbon resin. *U. S. Gasket Co., Div. Garlock Packing Co.—Booth* 1413.

Circle 813 on Yellow Card

Interval Timer

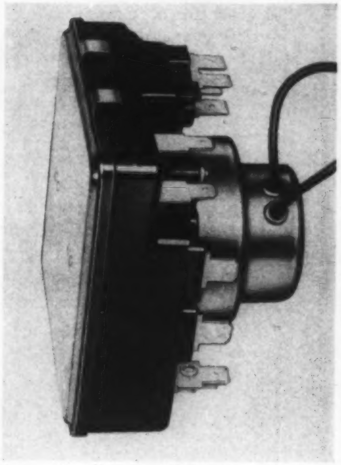
Designed for use on high-capacity electric appliances requiring 25-amp, 125-v switch rating, Model 105 timer can also be used in low-capacity appliances or wherever control is required for a preset period of time. Drive can be either clockwise or counterclockwise. *Controls Co. of America—Booth* 1416.

Circle 815 on Yellow Card

Pressure-Reducing Valve

One-piece body design of ⅜-in. valve incorporates integral relief and hydrostatic flow-control elements. Capacity is 8 gpm; valve is rated for 3000 psi maximum inlet pressure with adjustable reduced-pressure range of 25 to 2500 psi. *Vickers Inc.—Booth* 1428.

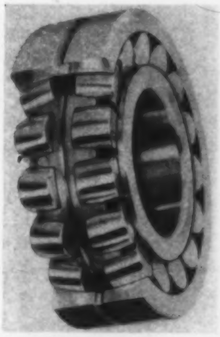
Circle 816 on Yellow Card



Silicon Power Rectifiers

For use in intermediate power-level application, SN-60 rectifiers are of rugged, all-welded construction and are hermetically sealed to withstand severe service. Thermal efficiency is less than 2 C. *Syntron Co.—Booth* 1436.

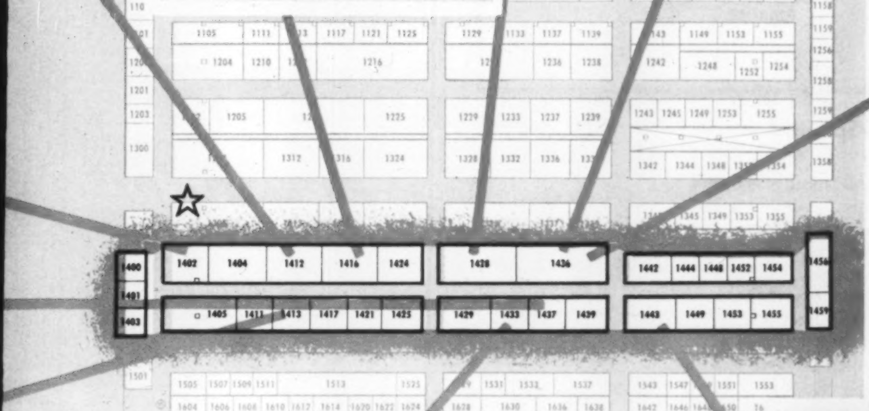
Circle 817 on Yellow Card

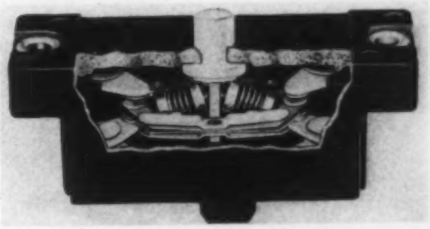


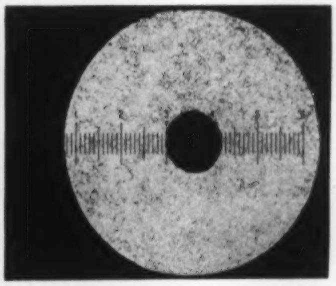
Self-Aligning Spherical Bearing

New line of spherical roller bearings features heavy inner-race flanges, centrifugally cast bronze retainer rings, and large-diameter rollers. *Link-Belt Co.—Booth* 1436.

Circle 818 on Yellow Card







3000-ft Long Capillary Tubing

Capillary tubing in longer lengths assures uniformity of size and permits use of one continuous length from sensing element to controls. Size checks include preparation of photomicrographs. Flow-tested tubing is supplied with a test report; flow rates can be tested from 5 to 3700 cu cm per min with gas pressures from 15 to 1500 psi. *Superior Tube Co.—Booth* 1433.

Circle 819 on Yellow Card

Movable-Contact Limit Switch

High electrical and mechanical life is provided by movable contact assembly which utilizes two compressed coil springs to provide quick make and break. A leaf spring, carrying the contacts, assures adequate contact pressure at all times, eliminates points of zero contact pressure, and provides non-teasing action even with extremely slow operating motion. *Cutler-Hammer Inc.—Booth* 1443.

Circle 820 on Yellow Card

★ EXHIBITORS

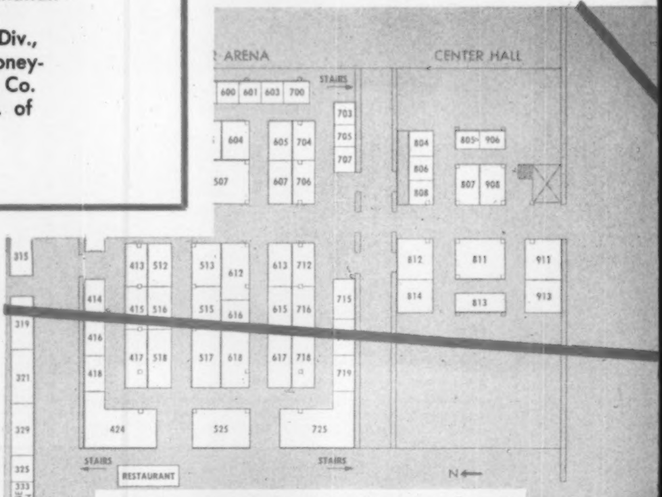
1500	Wittek Mfg. Co.
1501	Stokes Molded Products Div., Electric Storage Battery Co.
1504	Lovejoy Flexible Coupling Co.
1505	Rigidized Metals Corp.
1507	Globe Co.
1509	Whitney Chain Co.
1510	Dow Corning Corp.
1511	Detroit Controls, Div. American Radiator & Standard Sanitary Corp.
1512	Dayton Rubber Co.
1513	Eaton Mfg. Co.
1516	Kaydon Engineering Corp.
1520	Hitchiner Mfg. Co. Inc.
1524	Gries Reproducer Corp.
1525	*Electrical Manufacturing*
1528	Poloron Products, Inc.
1529	Veeder-Root Inc.
1531	Maurey Mfg. Corp.
1532	B. F. Goodrich Aviation Products, Div. B. F. Goodrich Co.
1533	Minnesota Mining and Mfg. Co.
1536	Adams & Westlake Co.
1537	U. S. Electrical Motors Inc.
1538	Imperial Brass Mfg. Co.
1542	Pennsylvania Fluorocarbon Co. Inc.
1543	Roehlen Engraving Works
1544	Modern Industrial Plastics Inc.
1547	Universal Castings Corp.
1548	Sier-Bath Gear and Pump Co. Inc.
1549	Dixon Sintaloy Inc.
1551	American Laubscher Corp.
1552	Lord Mfg. Co.
1553	Raybestos-Manhattan Inc.
1554	Micro Switch Div., Minneapolis-Honeywell Regulator Co.
1556	Mycalex Corp. of America

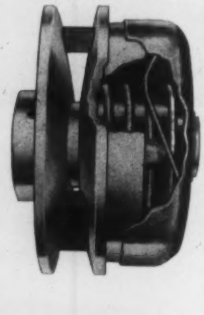
Precision Snap-Acting Switch

Bias and stresses which produce snap action in the TyniSwitch are inherent in a one-piece beryllium-copper blade. Fixed mounting of the blade is midway between the actuating and contact ends. Switch has sharp contact break and virtually bounceless contact make. Ratings are 15 amp and ½ hp, 125 and 250 v ac; 10 amp and 1/3 hp, 125 and 250 v ac. *Detroit Controls Div., American-Standard Corp.—Booth* 1511.

Circle 824 on Yellow Card

TyniSwitch
DETROIT CONTROLS CORP.
DETROIT, MICH.





Constant-Speed Pulleys

A cam automatically maintains required belt tension for a given load in Hi-Lo fhp variable-speed pulleys to keep speed constant regardless of wide variations in load. Pulley faces cannot spread, and pitch diameter is held at desired setting. Pulleys are made in ½, ¾, and 1-hp ratings. *Lovejoy Flexible Coupling Co.—Booth* 1504.

Circle 821 on Yellow Card

Pump Motor

Vertical hollow-shaft motor for turbine pumping is available for 1 to 125-hp operation. *U. S. Electrical Motors Inc.—Booth* 1537.

Circle 822 on Yellow Card

Electronic Counter

Transistorized Count-Pak operates accurately at speeds up to 30,000 counts per minute. It has a compact, glow-transfer, solid-cathode counting tube; a high-speed magnetic counter; and a small, adaptable photohead. *Veeder-Root Inc.—Booth* 1529.

Circle 823 on Yellow Card

Diecast Gear and Pinion

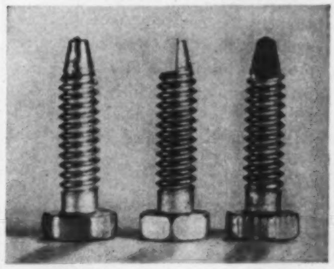
Stock interchangeable die units are available for 13 spur gears in pitch diameters of 0.500 to 1.500 in. and 15 pinions of matching pitch in pitch diameters of 0.250 to 0.417 in. Combinations of these die units provide 195 different gear and pinion combinations. *Gries Reproducer Corp.—Booth* 1524.

Circle 826 on Yellow Card

Self-Drilling, Self-Tapping Screw

Eliminating need for predrilling and alignment during assembly of sheet metal, plastic, or wood parts, Self-Drill, Self-Tap screw was developed for use with power tools in automated assembly operations. Screw can be preassembled with various locking or sealing washers for specific applications. *Reliance Div., Eaton Mfg. Co.—Booth* 1513.

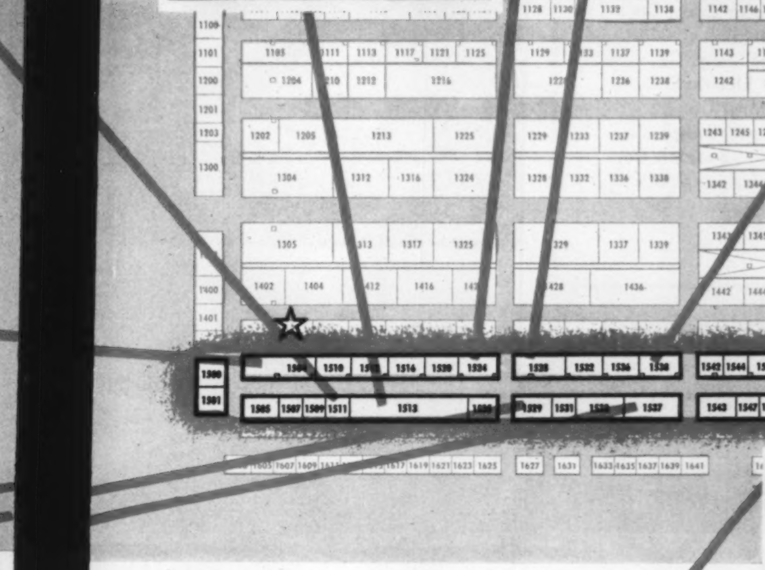
Circle 825 on Yellow Card

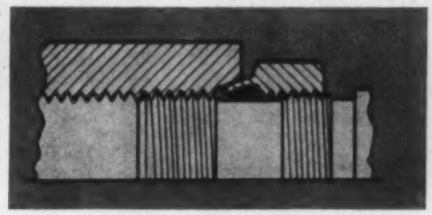


Vinyl-Metal Laminate

Standard tools can be used to draw, form, shape, punch, shear, seam, or perforate Atomite vinyl-to-metal laminate. Vinyl can be applied to any metal in sheets up to 48 in. wide, from 0.012 to 0.060 in. thick, on one or both sides. *Poloron Products Inc.—Booth* 1528.

Circle 827 on Yellow Card

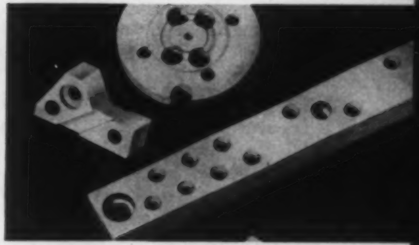




Port Seal

Port sealing of tube fittings by the Dura-Tite method utilizes a lock nut with a tubular portion at its base. Sealing medium is a split nylon or Teflon ring that fits between the tubular section and the fitting groove. Edge of coupling is crimped to retain the ring. *Imperial Brass Mfg. Co.—Booth* 1538.

Circle 828 on Yellow Card



Compressed Asbestos Sheet

Made in 0.008-in. thickness (±0.001-in.), A-56 compressed asbestos sheet withstands temperatures well over 1000 F. Tensile strength is 8000 psi. *Raybestos-Manhattan Inc.—Booth* 1553.

Circle 829 on Yellow Card

Single-Pulse Switch

Electronic circuit of 1PB600 series pushbutton switch produces a single, microsecond-length pulse with each operation. Square wave pulse of One-Shot switch is factory-adjustable from 0.2 to 2.5 mu sec; amplitude, from 3 to 60 v. Both width and amplitude are independent of speed of switch operation. *Micro Switch Div., Minneapolis-Honeywell Regulator Co.—Booth* 1554.

Circle 830 on Yellow Card

1550-F Insulation

Machinable Supramica 620 maintains dimensional stability at temperatures to 1550 F and under adverse conditions of thermal cycling, humidity, and moisture. Fineness and uniformity of texture permit machining to 0.0001-in. tolerances. *Mycalex Corp. of America—Booth* 1556.

Circle 831 on Yellow Card

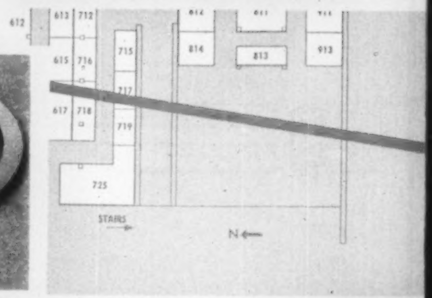
★ EXHIBITORS

1603	American Nickeloid Co.
1604	Newark Wire Cloth Co.
1606	Ramsey Corp., Subsidiary of Thompson Products, Inc.
1607	Thomas Flexible Coupling Co.
1608	Beaver Precision Products Inc.
1609	O'Sullivan Rubber Corp.
1610	Viking Pump Co.
1611	Mac-It Parts Co.
1612	Snap-Tite Inc.
1613	Sealol Corp.
1614	L and L Mfg. Co.
1615	Hamilton Watch Co.
1617	Martin Engineering Co.
1619	Cobehn Inc.
1620	Amplex Div., Chrysler Corp.
1621	Barco Mfg. Co.
1622	Beemer Engineering Co.
1623	Westline Products Div., Western Lithograph Co.
1624	Air-Maze Corp.
1625	Eriez Mfg. Co.
1627	New Hermes Engraving Machine Corp.
1628	Potter & Brumfield Inc.
1630	Judson L. Thomson Mfg. Co.
1631	Masland Duraleather Co.
1633	Weckesser Co.
1635	*Industrial Equipment News*
1635	Thomas Publishing Co.
1636	Cleveland Vibrator Co.
1637	Burling Instrument Co.
1638	Boston Gear Works
1639	Ohio Knife Co.
1641	Ohio Gear Co.
1642	Falstrom Co.
1646	American Pulley Co.
1647	Cooper Alloy Corp. (Foundry Products Div., Vanton Pump & Equipment Corp. Div.)
1648	Air-Shields Inc.
1649	Schlegel Mfg. Co.
1650	Furnas Electric Co.
1651	Stow Mfg. Co.
1652	Automatic Switch Co.
1653	American Sealants Co.
1655	Controlex Corp. of America

High-Oil-Content Bearings

Approximately 20 per cent by volume of oil in Iron Oilite 212 bearings provides lubrication for the life of many products in which they are used. Bearings are made in sleeve, flange, and spherical types. *Amplex Div., Chrysler Corp.—Booth* 1620.

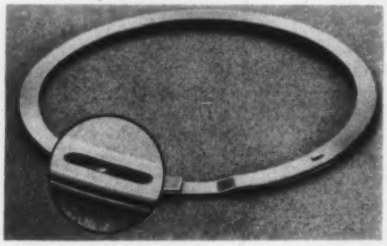
Circle 835 on Yellow Card

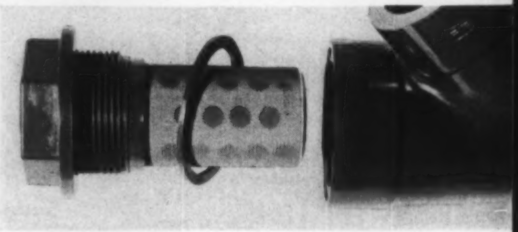


Self-Locking Retaining Ring

When centrifugal force is applied, Spirolox retaining ring automatically locks by means of two slots and two raised tabs. Designed for use with rotating elements or for applications where dirt or other foreign material tends to force a ring out of its groove, Spirolox is made from flat spring steel, coiled on edge to effect a 360-deg retaining surface. *Ramsey Corp.— Booth* 1606.

Circle 832 on Yellow Card

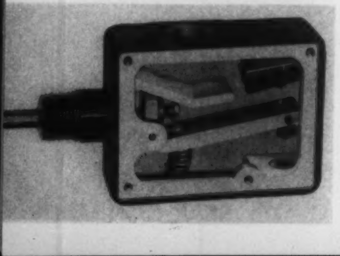




Compact Thermostat

Cigarette-pack size model M-1C thermostat has range of 100 to 600 F; other ranges up to 1000 F are available. Standard switch rating is 5 amp at 125-250 v ac, 3 amp at 30 v dc; other ratings are available. *Burling Instrument Co.—Booth* 1637.

Circle 833 on Yellow Card



High-Capacity Speed Reducer

Heavier bearings and shorter center distance between worm and gear enable Hi-Line reducer to provide up to 50 per cent greater capacity than models of similar size and weight. Units are fin and fan-cooled. Six sizes range from 1.33 to 5.25-in center distance. *Ohio Gear Co.—Booth* 1641.

Circle 834 on Yellow Card

Plastic Filter

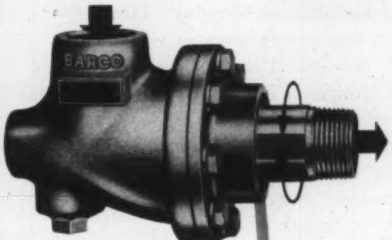
Light weight of polyvinyl chloride strainers permits installation directly on delicate equipment. Strainer element is readily accessible for cleaning or replacement. Sizes range from $1/2$ through 2 in. with socket-weld ends or molded thread ends. *Vanton Pump & Equipment Corp.—Booth* 1647.

Circle 836 on Yellow Card

Versatile Rotary Joint

Designed for steam, air, water, oil, gas, or alternating hot and cold service, type C rotary joint is also suitable for either single-flow or two-way syphon flow installation. Starting and running torques are low, even at high pressures. Joint is made in eight standard sizes from ½ to 3 in. *Barco Mfg. Co.—Booth* 1621.

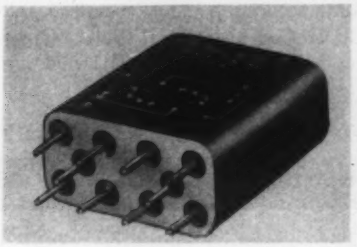
Circle 837 on Yellow Card

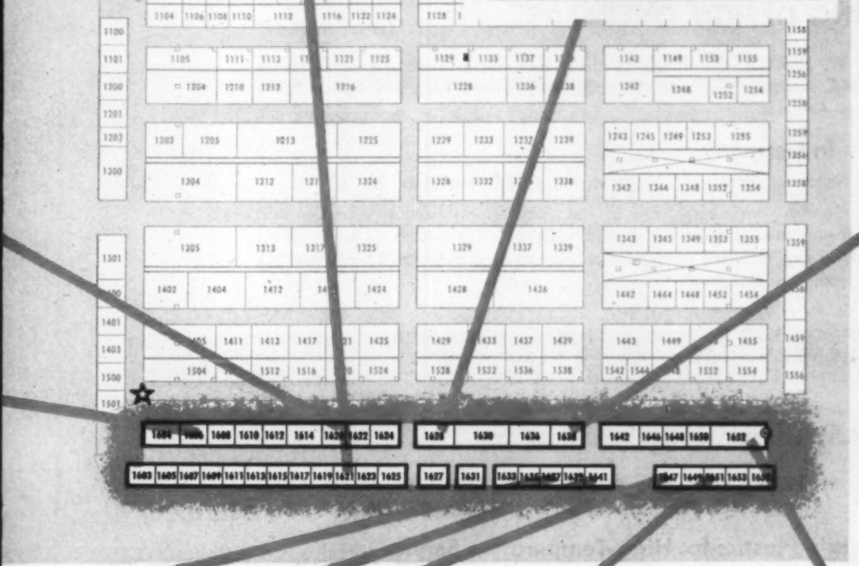


Automatic-Assembly Type Relay

Micro-miniature relay has terminals on 0.2 x 0.2-in. co-ordinates for mounting on printed-circuit boards by automatic assembly techniques. Dual-coil magnetic latching and single-coil-action types are available. Relay is 0.890 x 0.795 x 0.370 in. and weighs less than 20 grams. *Potter & Brumfield Inc.—Booth* 1628.

Circle 838 on Yellow Card

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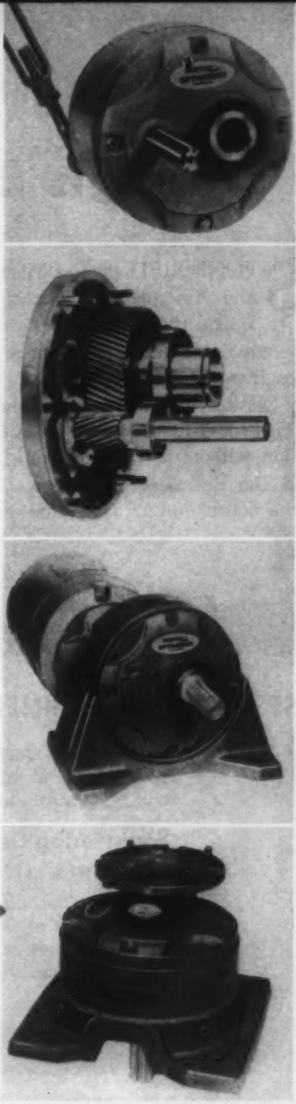
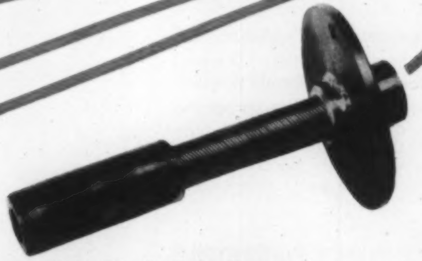


Universal-Mounting Speed Reducer

A basic Optimount speed reducer, with either single or double-reduction helical gearing, can be mounted directly on a driven shaft or mounted in standard horizontal or vertical bases. Four sizes provide output speeds of 10 to 431 rpm, capacities of 1/6 to 15 hp. *Boston Gear Works—Booth* 1638.

Circle 839 on Yellow Card



Flexible Shaft Coupling

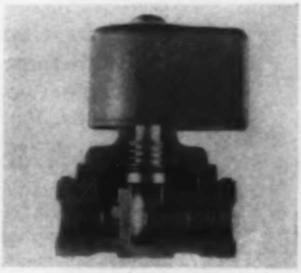
Flexble shaft core in coupling is made of music wire. Either end of the coupling can move while rotating. Six sizes, from 3/16 to 1¼ in. shaft core, are available. *Stow Mfg. Co.—Booth* 1651.

Circle 840 on Yellow Card

Direct-Lift Solenoid Valve

Two-way valve with only one moving part handles steam, air, gas, light oil, water, and other noncorrosive liquids and gases. It is available with a 5/16-in. orifice in either ⅜ or ½-in. NPT connections, for use at pressures up to 40 psi. *Automatic Switch Co.—Booth* 1652.

Circle 841 on Yellow Card



Design Engineering Conference

SPONSORED by the Machine Design Div. of the American Society of Mechanical Engineers, the Fourth Design Engineering Conference includes 14 papers, plus a talk on engineering design overseas.

Sessions will be held on the mornings of May 25 through 28 in Convention Hall. Opening session will be in the Ballroom; succeeding sessions, in the Ballroom and in meeting halls located at the south end of the large exhibition hall.

The Conference opener, which will include a panel discussion, is scheduled for Monday. Tuesday and Wednesday, concurrent sessions will be devoted to materials, power and control, and mechanical aspects of design. Thursday's session will deal with general engineering.

Conference registration fees are $5 for ASME members and $10 for nonmembers. Fees include copies of papers presented at Sessions II through VIII and admission to the show.

Monday, May 25 — 10 a.m.

SESSION I – ENGINEERING DESIGN OVERSEAS

Co-Chairmen: JOSEPH W. BARKER, Chairman of the Board (ret.), Research Corp., New York; **CARL W. BESSERER,** Assistant Program Director, Minuteman Program, Space Technology Laboratories, Los Angeles.

Engineering Design in Germany

HELLMUTH WALTER, Director of Research, Worthington Corp., Harrison, N. J.

Technical education of German engineers, role of the engineering executive in German industry, loss of German engineering talent to Russia, and the relationship of engineering to other phases of industry are included in discussion. A panel session following the talk will answer questions from the audience.

Tuesday, May 26 — 9:30 a.m.

SESSION II – MATERIALS

Co-Chairmen: JOHN C. REDMOND, Pittsburgh; **ROBERT N. PETERSON,** Supervisor, Application Design Group, E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.

Latest Developments in Plastics for High-Temperature Service

IRVING J. GRUNTFEST, Materials Studies, Aerosciences Laboratory, Missile and Space Vehicle Dept., General Electric Co., Philadelphia.

Short exposures of material to high temperatures, in such applications as rocket motors or skin of high-speed aircraft and missiles, permits consideration of plastics. Thermal conditions in high-speed applications are analyzed, and a detailed description is given of the four stages the material being heated may go through. Phenolics, graphite, Teflon, glass-reinforced phenolics, and other plastic materials of the thermosetting type are covered.

Latest Developments in Metals and Ceramics For High-Temperature Service

JULIUS J. HARWOOD, Head, Metallurgy Branch, Office of Naval Research, Department of the Navy, Washington, D. C.

Changing requirements have necessitated different approaches and emphasis in developing new types of high-temperature materials. Thermal properties of metals, refractory metals, thermal-protection systems, and composite materials are significant in materials development. Current approaches to the problems of high temperature are discussed briefly, and materials are evaluated with respect to high-temperature capabilities, potentialities, and limitations. Future trends are forecast.

SESSION III – POWER and CONTROL

Co-Chairmen: DONALD G. DUTCHER, Chief Electrical Engineer, Hanson-Van Winkle-Munning Co., Matawan, N. J.; **R. BARNITZ,** Chief Electrical Engineer, Jones & Laughlin Steel Corp., Pittsburgh.

Variable-Speed DC Drive Systems

M. H. SLUIS, Electrical Engineer, Pratt & Whitney Co. Inc., West Hartford, Conn.

Directed to designers who recommend drives for given applications, discussion includes data on the three most commonly used methods for obtaining variable speed control on dc motor drives. Principles of operation and relative performance of rotary, magnetic, and electronic systems are given.

DC Conversion Devices

J. J. RHEINHOLD, Vice President, Richardson-Allen Corp., College Point, N. Y.

Copper oxide, selenium, germanium, and newest power-type silicon rectifier elements are covered, as well as design parameters for system use. Information required to choose an element is provided.

SESSION IV – MECHANICAL

Co-Chairmen: FRANCIS L. JACKSON, Technical Director, Franklin Institute Laboratories for Research and Development, Philadelphia; **T. R. RIDEOUT,** Consulting Engineer, Port Chester, N. Y.

Design and Application of Belts, Chains, and Gears

E. S. CHEANEY, W. C. RARIDAN, and C. L. PAULLUS, Principal Engineers, Product Development Div., Battelle Memorial Institute, Columbus, Ohio.

Recent advances in belts, chains, and gears are pointed out, and a method is presented for the preliminary selection of the most suitable drive. Selection is based on a comparison between requirements and characteristics of drive.

Clutch, Fluid Coupling, Torque Converter—Application Considerations and Performance Comparisons

ROBERT W. BACHMANN, Application Engineer, Hydraulic Div., Twin Disc Clutch Co., Rockford, Ill.

Performance features of three basic power-transmission drive devices are compared as to output performance characteristics. Curves and charts show that no particular type of drive is categorically superior to others.

Wednesday, May 27 — 9:30 a.m.

SESSION V – MATERIALS

Co-Chairmen: E. H. PHELPS, Assistant Division Chief, Chemical-Metallurgy Div., Applied Research Laboratory, U. S. Steel Corp., Monroeville, Pa.; **R. V. VANDEN BERG,** Head, Finishes Section, Process Development Laboratories, Aluminum Co. of America, New Kensington, Pa.

Latest Developments in Materials To Resist Chemical Corrosion

S. W. SHEPARD, Materials Engineer, Chemical Construction Corp., New York, N. Y.

Improvements in existing materials, new forms and combinations, increased availability, and effective use of materials result in better corrosion resistance. Aluminum alloys, hardenable grades of stainless steel, ductile iron, plastics and elastomers, fluorocarbons, and ceramics are discussed.

Latest Developments in Materials and Coatings To Resist Atmospheric Corrosion

E. BURT FRIEDL, Principal Chemist, Corrosion Research Div., **LOUIS J. NOWACKI,** Assistant Chief, Organic Coatings Research, and **WILLIAM H. SAFRANEK,** Assistant Chief, Electrochemical Engineering Div., Battelle Memorial Institute, Columbus, Ohio.

Recent advancements in materials to combat deterioration by weathering are discussed and specific consideration is given to protection of steel by organic or metallic coatings.

SESSION VI – POWER and CONTROL

Co-Chairmen: JAY W. PICKING, Manager, Control Div., Reliance Electric and Engineering Co., Cleveland; **A. M. KIMBALL,** Manager, Digital Control Engineering, Director Systems Dept., Westinghouse Electric Corp., Pittsburgh.

Digital Systems for Control Applications

ISAAC L. AUERBACH, President, Auerbach Electronics Corp., Narberth, Pa.

Underlying principles involved in translating dimensional data from a drawing to a part in metal produced on a numerically controlled machine are outlined. Examples are cited.

Logic Circuits for Machine Control

EDGAR V. WEIR, Consulting Engineer, Magnetics Inc., Butler, Pa.

Addressed to the designer who has a problem of selecting and applying a control system, discussion defines functions performed by control units. Three commercially available static control systems for industrial machinery applications are compared, with examples of application for each.

SESSION VII – MECHANICAL

Co-Chairmen: DUDLEY FULLER, Professor, Mechanical Engineering Dept., Columbia University, New York; **STANLEY ABRAMOVITZ,** President, Continental Bearing Research Corp., New York.

Design Curves for Journal Bearings

DONALD F. HAYS, Research Engineer, Mechanical Development Dept., Research Laboratories, General Motors Corp., Warren, Mich.

Technique for analyzing a full journal bearing of finite length is illustrated with design curves. Curves apply to the full journal bearing of finite width with a continuous oil film. Lubricant is assumed to be incompressible and the Reynolds' number small.

Which Bearing and Why

ARNOLD O. DeHART, Research Engineer, Mechanical Development Dept., Research Laboratories, General Motors Corp., Warren, Mich.

Comprehensive coverage of bearing types—fluid film and rolling contact—includes suggestions for application and examples. Bearing types which show promise in machine-tool applications are emphasized.

Thursday, May 28 — 9:30 a.m.

SESSION VIII – GENERAL ENGINEERING

Co-Chairmen: THOMAS W. HOPPER, President and Director, Day & Zimmermann Inc., Philadelphia, Pa.; **G. L. BROOMELL,** Director of Engineering, Leeds & Northrup Co., Philadelphia.

A Graphic Method for Engineering Organization

E. M. RAMBERG, Vice President-Engineering, Titeflex Inc., Springfield, Mass.

Assigning numerical values to various functions of an engineering design department provides a method of evaluation that eliminates the human-behavior factor. Graphical method defines shortcomings and suggests check points. Charts explain method and examples.

The Man and the Organization

MARTIN M. BRUCE, Vice President and Director, Psychological Services, Clark, Channell Inc., Stamford, Conn.

Organizational structure that meets the needs of both management and the individual is suggested. Discussion includes management's responsibility in communicating its goals and helping employees realize objectives.

Design Engineering Show

EXHIBITORS

CONVENTION Hall's arena, lower arena, center hall, and main exhibition hall will be filled with thousands of products, providing a design engineer's marketplace of ideas and information.

The Show will run four days—May 25-28—and will be open from noon to 5:30 p.m. on Monday, Wednesday, and Thursday, and noon to 9:30 p.m. on Tuesday. Registration fee is $2, payable at the Show. Special bus service between major downtown hotels and Convention Hall will be maintained during exposition and conference hours.

Exhibitors and booth numbers are listed here and on the following pages; a floor plan of exhibit areas is on Pages 228 and 229.

MACHINE DESIGN will welcome visitors at booth No. 333.

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Bunting Brass and Bronze Co.	1021
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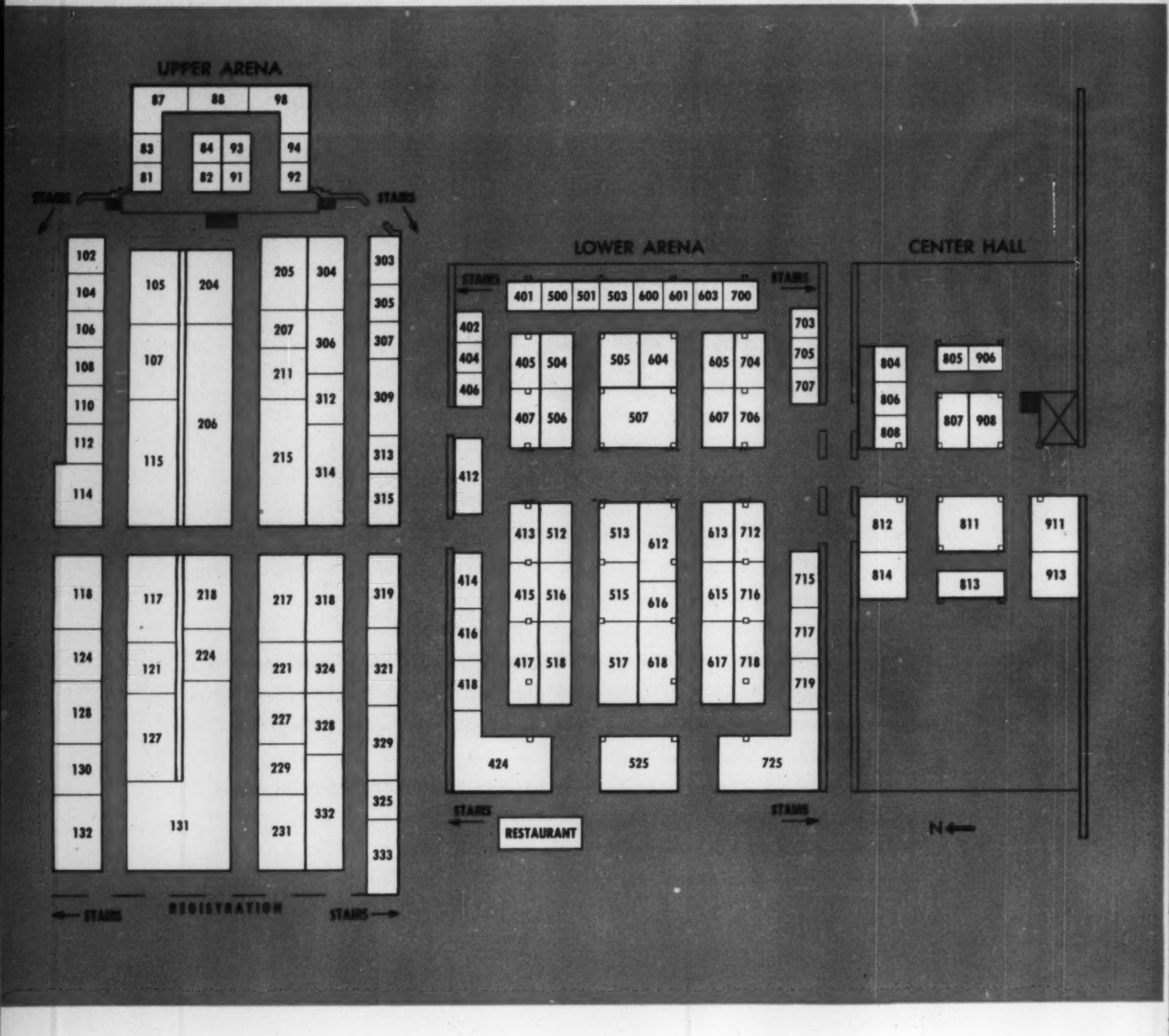
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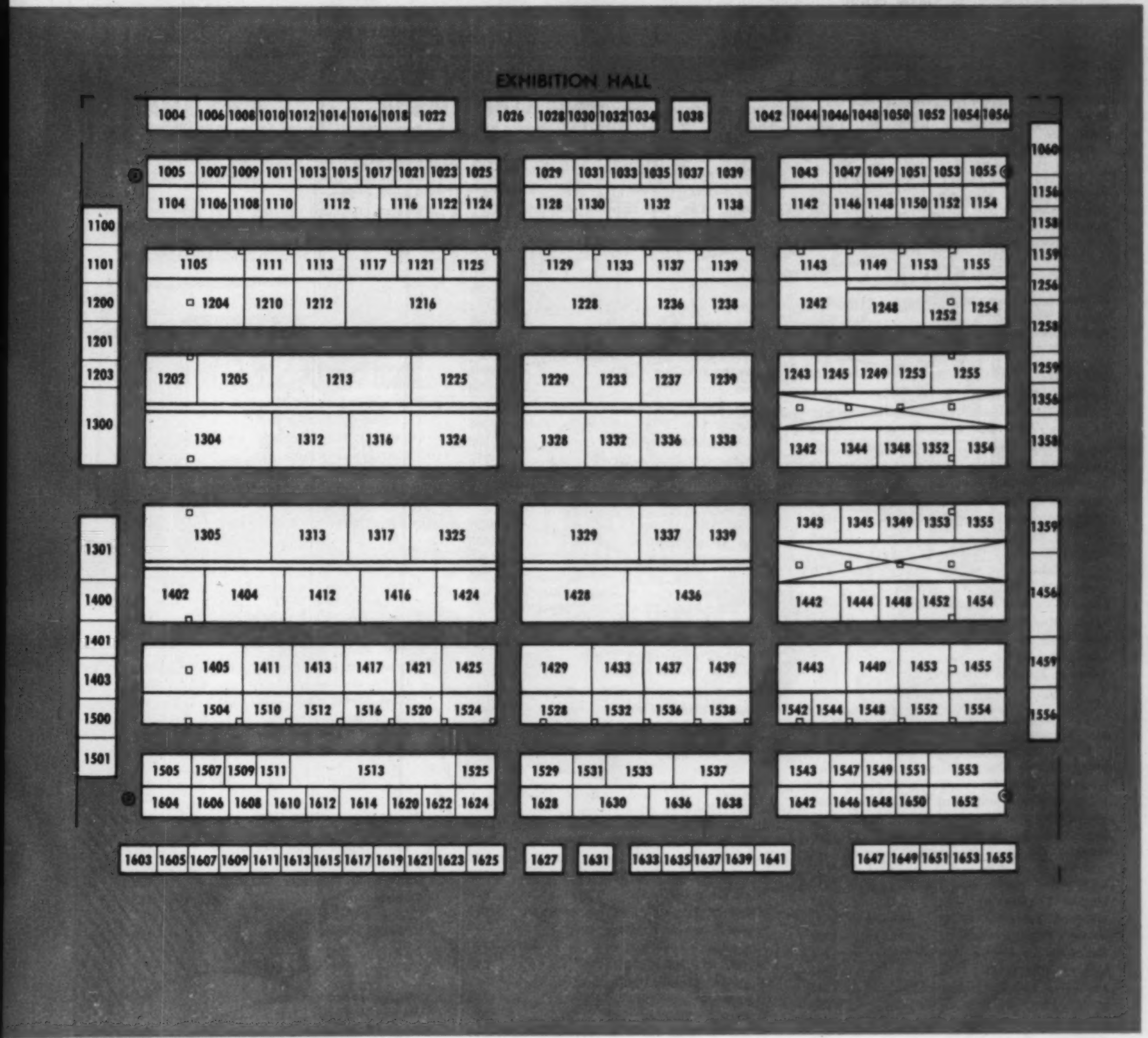
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Edwin L. Wiegand Co.	1200
Winsmith Inc.	1256
Wittek Mfg. Co.	1500
T. B. Wood's Sons Co.	1117

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Zero-Max Co., A Subsidiary of Revco Inc.	700

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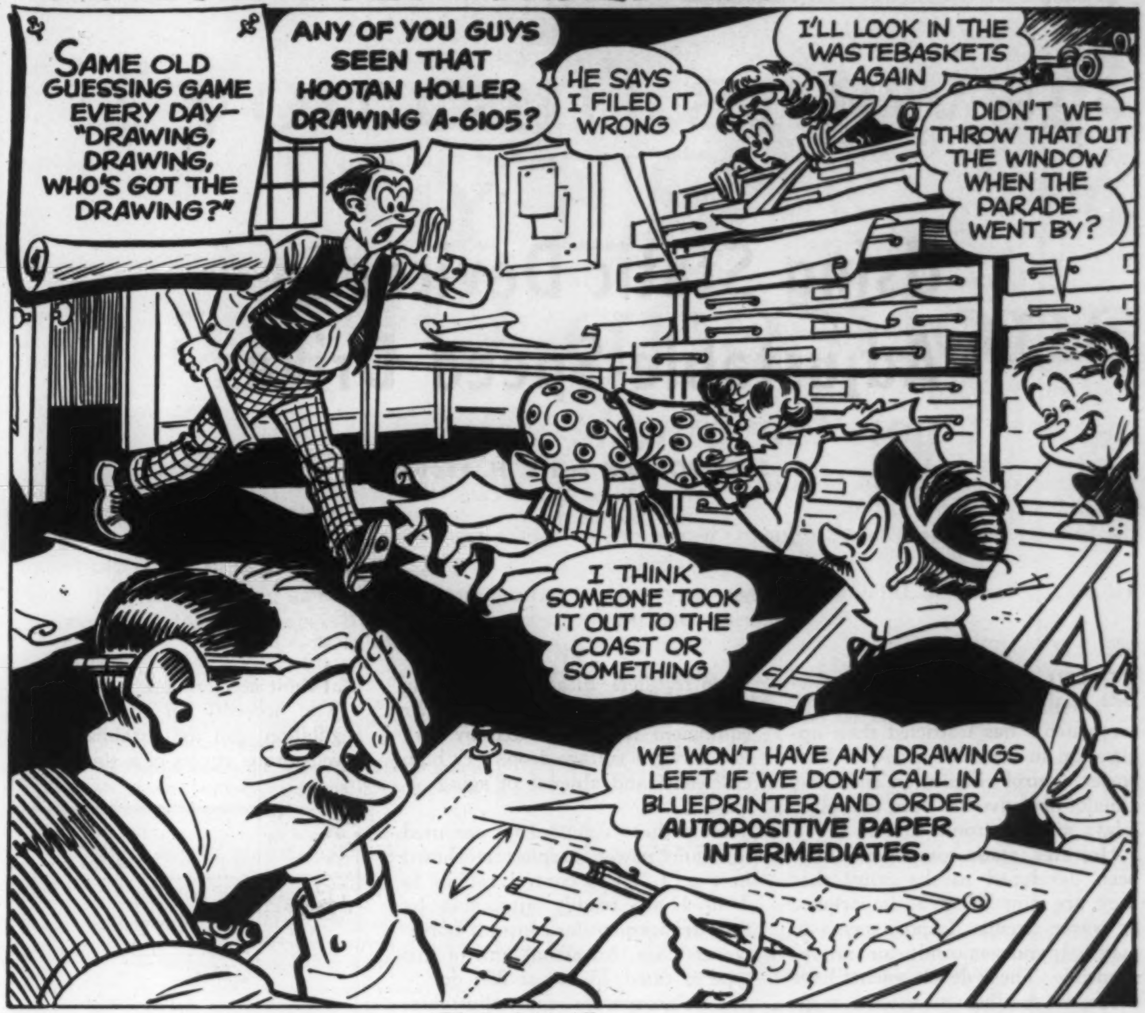
THERE MUST BE AN EASIER WAY


SAME OLD GUESSING GAME EVERY DAY—"DRAWING, DRAWING, WHO'S GOT THE DRAWING?"
ANY OF YOU GUYS SEEN THAT HOOTAN HOLLER DRAWING A-6105?
HE SAYS I FILED IT WRONG
I'LL LOOK IN THE WASTEBASKETS AGAIN
DIDN'T WE THROW THAT OUT THE WINDOW WHEN THE PARADE WENT BY?
I THINK SOMEONE TOOK IT OUT TO THE COAST OR SOMETHING
WE WON'T HAVE ANY DRAWINGS LEFT IF WE DON'T CALL IN A BLUEPRINTER AND ORDER AUTOPOSITIVE PAPER INTERMEDIATES.

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Using Static Devices in Adjustable-Speed Drives

S. E. MORGAN and E. H. VEDDER
Westinghouse Electric Corp.
Buffalo, N. Y.

UNTIL recently, the limited power-handling ability of static components has restricted their application in control systems to low-power control circuits. In such use, a major objective has been to replace relays and electronic tubes.

However, static components have been developed to the point that they are now of great importance in power circuits. Improvements in materials and semiconductors are responsible. These developments have made it possible to extend magnetic-amplifier principles beyond nominal applications in control circuits to applications in which large blocks of power are handled.

An industry trend is shown by the growing popularity of the package-drive concept. Advantages afforded by completely factory-wired and tested units are obvious, but tangible benefits show up in the final installed cost of such a drive. As improvements are made, the objective of the electrical industry will be to produce package drives at lower cost, maximum performance and flexibility, and minimum physical size. Static power-conversion units represent a major step in this direction.

For example, silicon rectifiers show distinct advantages over selenium rectifiers. In addition to being much more compact, silicon rectifier equipment is characterized by very low forward voltage drop, very high efficiency, and absence of aging effects.

How these components are used in static power supplies is shown in Fig. 1. Speed-control ranges to 4 to 1 are readily attainable by this arrangement for constant-horsepower loads. An actual unit of this type is rated 75 kw at 250 dc.

To incorporate the adjustable-voltage feature so as to provide wide speed-control ranges by armature-voltage control, power and control magnetic amplifiers are added as shown in Fig. 2. Note that speed-control rheostats are provided for both the armature control and motor field control. Here, a combined constant-torque and constant-horsepower speed range is available. How the power magnetic amplifier is used in a complete motor drive is shown in Fig. 3.

Operating from a three-phase source, through a circuit breaker affording overcurrent protection, the power reactors and silicon rectifiers are connected directly to the line. The control circuit is energized when the "M" contactor is closed. This circuit provides adjustable-current-limit acceleration.

The necessity for some form of regulation can be established by speed-torque curves of a simple sys-

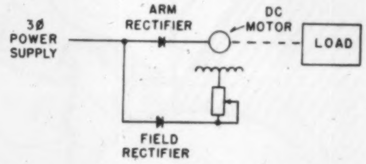

Fig. 1—Static, adjustable-speed constant-horsepower drive. Only the dc-motor field is controlled to provide adjustable speed.

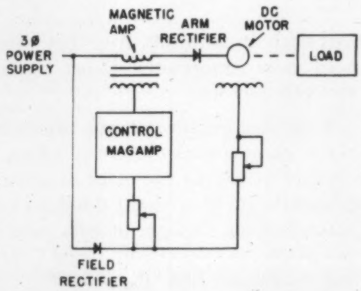

Fig. 2—Static, adjustable-voltage drive. Speed-control rheostats are provided for the armature control and motor field control.

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3	If a locking action is used on the set screw itself, other than the point, have the new types available been compared for cost-reduction possibilities?	☐	☐
4	Have the types of set screws or socket cap screws been reviewed recently for their dependability and performance?	☐	☐
5	Have other types of locking heads been checked as possible alternatives for reducing costs or speeding up insertion rates?	☐	☐
6	Have other basic metals of set screws or socket cap screws been compared as possible alternatives for better hold or cost reduction?	☐	☐
7	Has hopper feeding of set screws been considered as a production increasing, reject-stopping method?	☐	☐
8	Have the set screws now being used been reviewed because of recent design changes in product that cause extra stress, vibration, etc., on screws?	☐	☐
9	Have the set screws or socket cap screws been reviewed because of new product used that could affect performance?	☐	☐
10	Have the set screws been reviewed because of changes in the materials they are used on?	☐	☐

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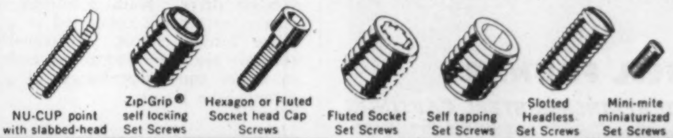

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Circle 524 on Page 19

tem which show that the inherent droop of the drive is too great for most applications. With the compensation set for essentially flat regulation at 20 per cent of top speed, the drive will perform with regulation within about ±5 per cent of top speed.

The principal advantages that can be expected from drives of this type are:

1. High efficiency of the over-all system. Efficiency above half speed is in the range of 70 to 83 per cent. In contrast, typical efficiency for an m-g set ranges from 63 to 73 per cent.
2. Low maintenance, long life, and extreme reliability of the power package. Magnetic amplifiers, power reactors, and silicon diodes provide the benefits now established as characteristic of static-control components.
3. Elimination of the dc contactor. Since opening and closing of the power circuit is performed ahead of the rectifiers, advantages of ac interruption are made available to the user.
4. Compactness of design requires minimum floor space.
5. Elimination of need for reduced-voltage ac starters. These are never required since inrush currents are low.

In addition, other features include wide speed ranges (8 to 1 is standard for armature control); smooth, stepless control over acceleration and deceleration; dynamic braking; adjustable inching or threading speeds; and compatibility with various types of functional regulators operating over the entire speed range.

The one characteristic not available in this reactifier-drive system is regenerative braking. It is obvious

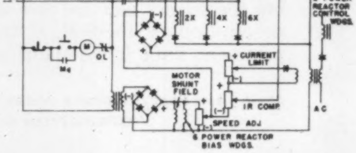


Fig. 3—Type AVR (rectifier) adjustable-voltage drive. Main windings of the power reactor are connected in a three-phase bridge circuit. Voltage-dividing resistors are connected across each diode to insure equal distribution of a surge through the circuit.

that the blocking action of the silicon diodes would prevent any reverse power flow. However, in many applications, this feature can be approximated by use of dynamic slowdown or intermittent application of dynamic braking during speed changes.

Applications of these reactifier drives appear to be essentially unlimited except for certain cases in which the fast-acting and stepless function of regenerative braking is essential. (These would be chiefly encountered in connection with highly accurate regulation systems with high-inertia loads.) Otherwise, these drives are immediately practical and available.

Paper A-5918, Presented at the 23rd Annual Machine Tool Electrification Forum, Buffalo, April, 1959; 6 *pp.*

Tailoring Density in Powder-Metal Parts

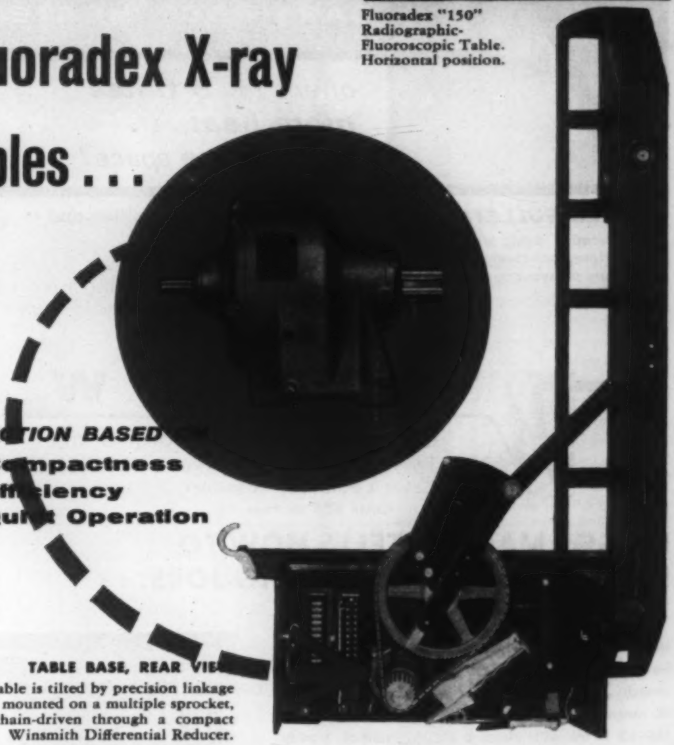
THE powder-metal process introduces a fourth dimension to metals engineering in the form of controllable density or controllable porosity. This feature of the process is responsible for many new applications of powder-metal parts because of the unique properties obtainable. A powder-metal part can be made hard and dense in one area and soft and porous in another. It is now possible to tailor properties to meet exactly the physical requirements of an application.

Porosity is often considered undesirable in conventional metal-forming practice largely because it is uncontrollable. In powder metallurgy, porosity can be eliminated entirely or used to any desirable degree as the major quality of a particular part.

Advantages of controllable porosity also enter into applications where this quality is not deliberately sought. Gears for timing mechanisms, for example, have been converted from the blanking process because of costs. The inherent surface porosity of the powder-metal part has been found to give smooth-

Winsmith speed reducers specified for Westinghouse Fluoradex X-ray tables . . .

Fluoradex "150" Radiographic-Fluoroscopic Table. Horizontal position.



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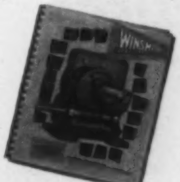

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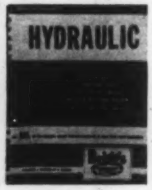

Circle 527 on Page 19

er functioning and longer life.

Metal powders most widely used for structural parts are iron, copper, brass, bronze, nickel silver, alloy steel, and stainless steel. In all cases, porosity of the compact is predetermined by selection of grain size of the material, the lubricant mixture, molding pressure, and sintering conditions. Extreme porosity, such as that used for filter materials, is obtained by using atomized spherical powders of closely controlled grades.

Parts having densities on the order of 50 per cent of theoretical are used as filters and for other similar applications. Self-lubricating bearings are in the order of 75 per cent theoretical density. Structural and mechanical powder-metal parts have densities ranging from about 80 to above 95 per cent.

Ordinary powder-metal bearings hold from 10 to 40 per cent oil by volume and have the advantage of supplying additional lubricant as heat expands the oil. The oil is again reabsorbed on cooling to be held ready for use when needed.

Controllable porosity is important in the design and application of filters. Designers can take advantage of the strength and corrosion resistance of nonferrous and stainless metals and, at the same time, produce a filter of closely controlled permeability in almost any configuration including cones, and tubes.

An important function of sintered filters stems from their ability to separate or pass materials selectively. They can also be used to diffuse the flow of gases or liquids, regulate flow or pressure drop in supply lines, or act as flame arrestors by cooling gases below combustion temperatures. Filter ability may be altered materially by electroplating filter elements.

Powder Metallurgy Quarterly, *Spring*, 1959; 4 *pp*.

electrical

A Proposed Program for Evaluating Electrical Connectors

R. H. Paccone, IBM Corp.

Description of a comprehensive test designed to evaluate merits of weld-

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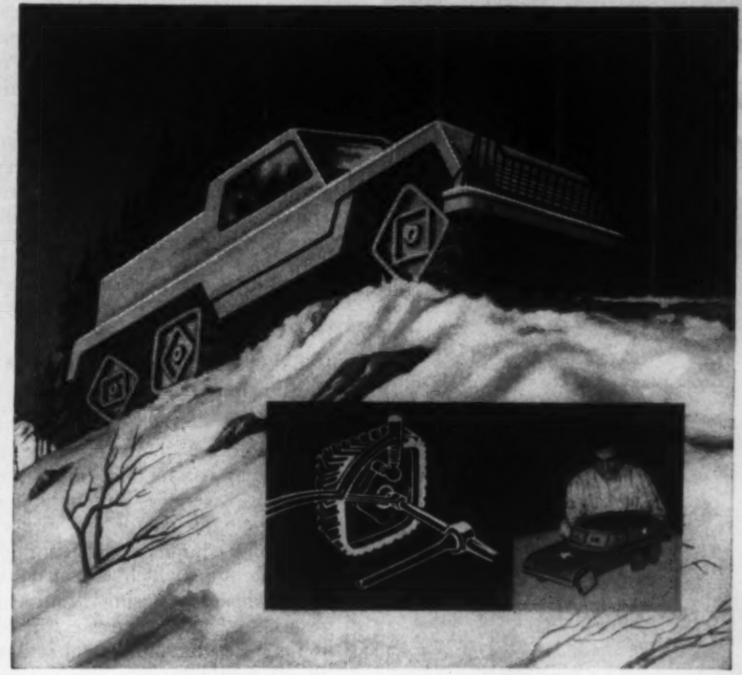

SQUARE WHEELS? Yes ... square wheels. Operating by means of a floating axle and cam gear, they take the bumps out of rough terrain and provide more traction. U.S. Patent No. 2786540 has been granted to designer Albert Sfredda of Bethlehem, Pa., for his invention.

The square shape gives superior traction in mud, sand, snow or uneven terrain. The flat surfaces of the wheels bridge the ruts instead of sinking into them as do round wheels. The wheels can be in any relative position, do not need to be synchronized—yet they run smoothly. Designed for use on heavy trucks, jeeps, farm or construction machinery, speeds up to 35 miles per hour can be attained.

This ingenious departure from age-old precedent is just one example of the contributions that today's designers are making. To help them translate their pace-setting ideas from concept to reality they require the best of drafting tools.

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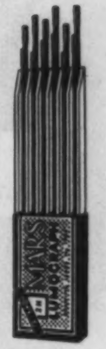

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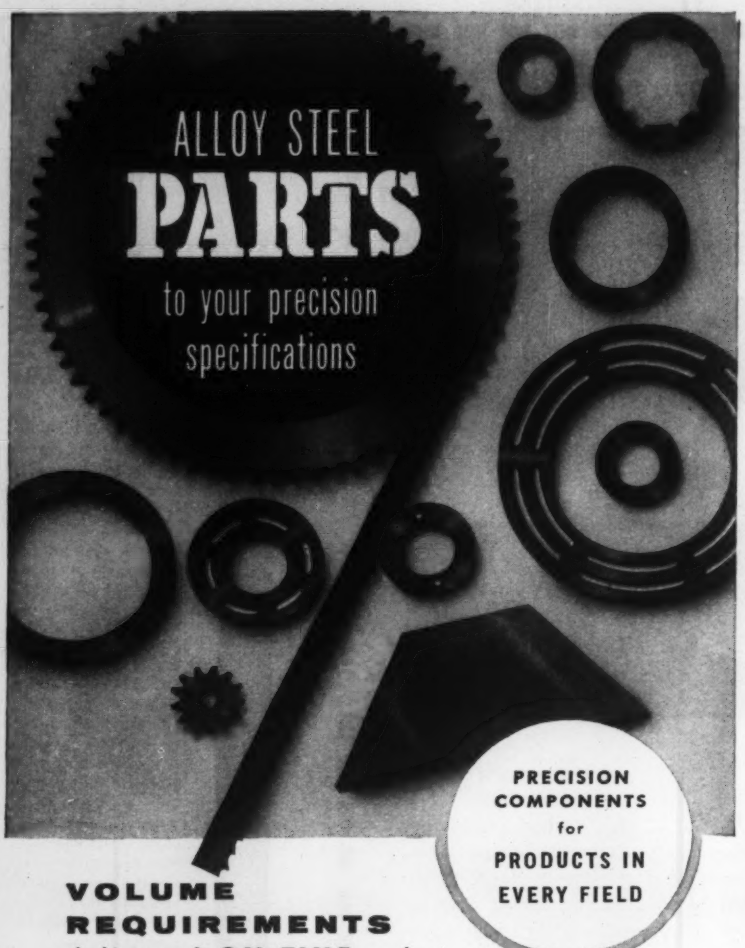
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ed, soldered, and plugged electrical connections. Unreliability of present soldered connections is indicated by reference to results of a previous soldered-connection test. Precise methods of testing the three types of connections are covered in detail and includes fabricating and mounting techniques, types of environmental stresses encountered, and methods for measuring resistance of the connection.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 12 pp.

Behavior of Soldered Joints in Vibrating Printed Circuits

E. W. Broache and A. T. Hamill

Why soldered joints must be expected to exhibit mechanical strength in service. Emphasis is on printed-circuit boards for airborne electronic equipment. Tests duplicate vibration which is transmitted to the boards, causing flexure and resulting bending stresses in the joints. Results indicate that large fillets of solder improve the flexure life of printed-circuit joints where eyelets are used. There is also evidence to indicate that elimination of eyelets might be advantageous. Where possible, circuitry should exist on only one side of the board thus eliminating necessity for through connections and making a dip soldering process more feasible.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 5 pp.

Soldered Connections for High-Temperature Operation

G. L. Branch and R. Y. Scapple

Advantages of resistance soldering in electronic applications where miniaturization decreases accessibility of components. Suitable solder alloys, fluxes, and soldering techniques were investigated in addition to the type of plated surface or surfaces that offers the required combination of good solderability and resistance to degradation by environment. The extent of metallic diffusion between the base metal and platings, and between the platings themselves, was a criterion used for determining suitability of platings. Results indicate that the re-

Circle 529 on Page 19

sistance method of soldering is capable of consistently producing a uniform connection.

Other conclusions are that: For 500 F operation, gold plate over nickel plate, rhodium plate over silver plate, and nickel plate over copper-base metals provide good solderability and resistance to metallic diffusion; gold plate over silver plate and silver plate over copper-base metals are not satisfactory for 500 F use; flux residue must be removed from high-impedance circuits if a high degree of reliability is required; soldered connections exposed to environmental testing show no evidence of corrosion.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 8 pp.

Optimum Size Ratios Between Wires of Welded Connections

O. B. Shafer, IBM Corp.

Effects of size ratios in relation to material used in component leads on the quality of spot-welded connections. Results were used to determine best size ratios for component connections to a wire grid and to determine the best material to be used in the grid so that all leads would weld readily. Data is of use in the design of welded modular packages. Strength-ratio versus size-ratio curves provide a convenient means for determining combinations of wires that can be successfully welded together.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 10 pp.

Ultrasonic-Welded Al-Cu Joints As Electrical Connections

D. McCarthy, V. Pirc, and W. Hannahs, American Machine and Foundry Co.

A report on the capacity of ultrasonic-welded aluminum-copper junctions for carrying an electric current. The study also determines what changes occur within the joint after long periods of operation, effects of overloading and of surges due to off-on current, and effects of environment on joint strength. Joints were compared with those made by other methods such as soldering and condenser-discharge welding. Results indicate that good

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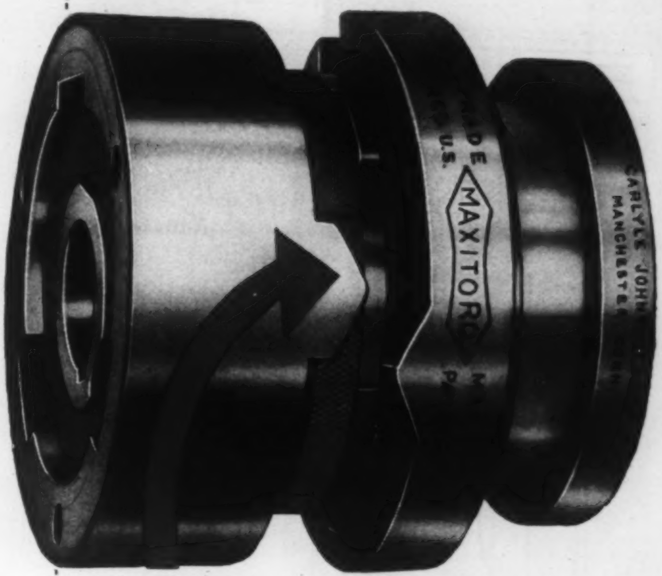

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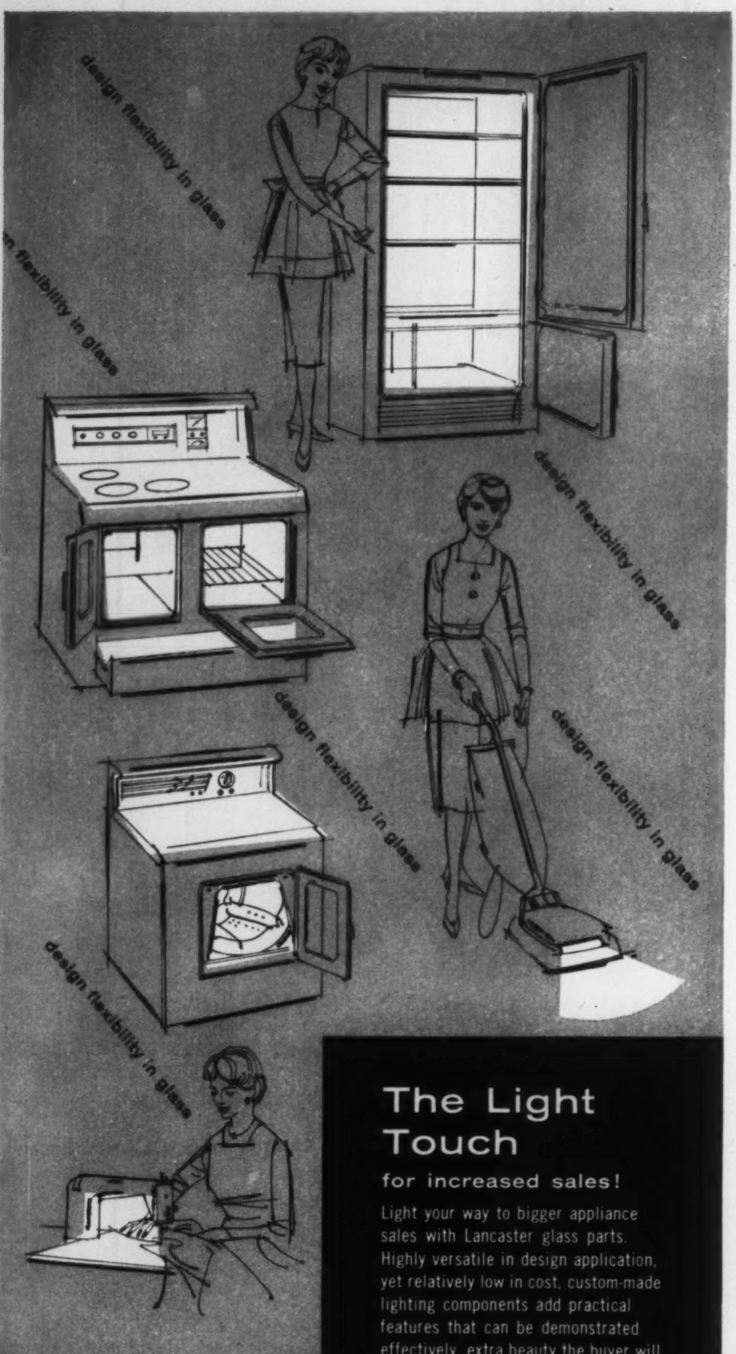
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joints are obtainable by ultrasonic welding and that size can be much smaller than that of soldered joints because of improved conductivity. Mechanical strength is good.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 9 pp.

Shielded-Wire Terminations

J. T. LaForte, General Electric Co.

Advantages of a simple, fast, inexpensive, and reliable method of connecting a ground lead to the shield of coaxial cable and shielded wire. The process consists of casting molten solder around the junction of the two. This method avoids disadvantages of using the braid as the ground lead, of soldering the ground lead to the braid, and of using crimped ferrules.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 6 pp.

Application and Reliability of Connect-Disconnect Plugs

I. G. Rabbin, North American Aviation Inc.

How proper application of electrical plugs and connectors influences maintainability of electronic equipment. Reliability studies indicate that plugs and connectors contribute to only a small percentage of total failures of any given electronic equipment. Although their use contributes to a small decrease in reliability, overwhelming advantages are claimed in maintenance and repair areas. Advantages are claimed to surpass benefits derived from any other means of connections.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 8 pp.

lubrication

Effects of Turbulence on Slider-Bearing Lubrication

Ye Tsang Chou and E. Saibel, Rensselaer Polytechnic Institute

Derivation of a pressure equation for turbulent flow in slider-bearing lubrication. An analytical solution is given and compared with one for laminar flow. It is found that the turbulent effect increases pressure and load-carrying capacity of the bearing. However, power loss also increases. A numerical example compares the relative magnitudes of pressure distribution in turbulent and laminar flows.

ASME paper 58-A-30, ASME Annual Meeting, New York, December, 1958; 5 pp.

Measurement of Oil-Film Thickness in Gear Teeth

I. O. MacConochie and A. Cameron, Imperial College, London

Details of a voltage-discharge method used to study lubrication of gears running under load. The method demonstrates the existence of an oil film of considerable thickness at the pitch line. It is approximately of the same order of magnitude as that predicted by theoretical analysis. Severity of gear-tip conditions found during these experiments may help explain why disc machines of the SAE Timken, or similar types do not always give good correlations with gears. In disc machines, moving members are under a steady load and do not have anything comparable with the sharp edge of the tip of the teeth. The experiment also shows how much the condition of lubrication at the ends of the contact line can be altered by tip relief.

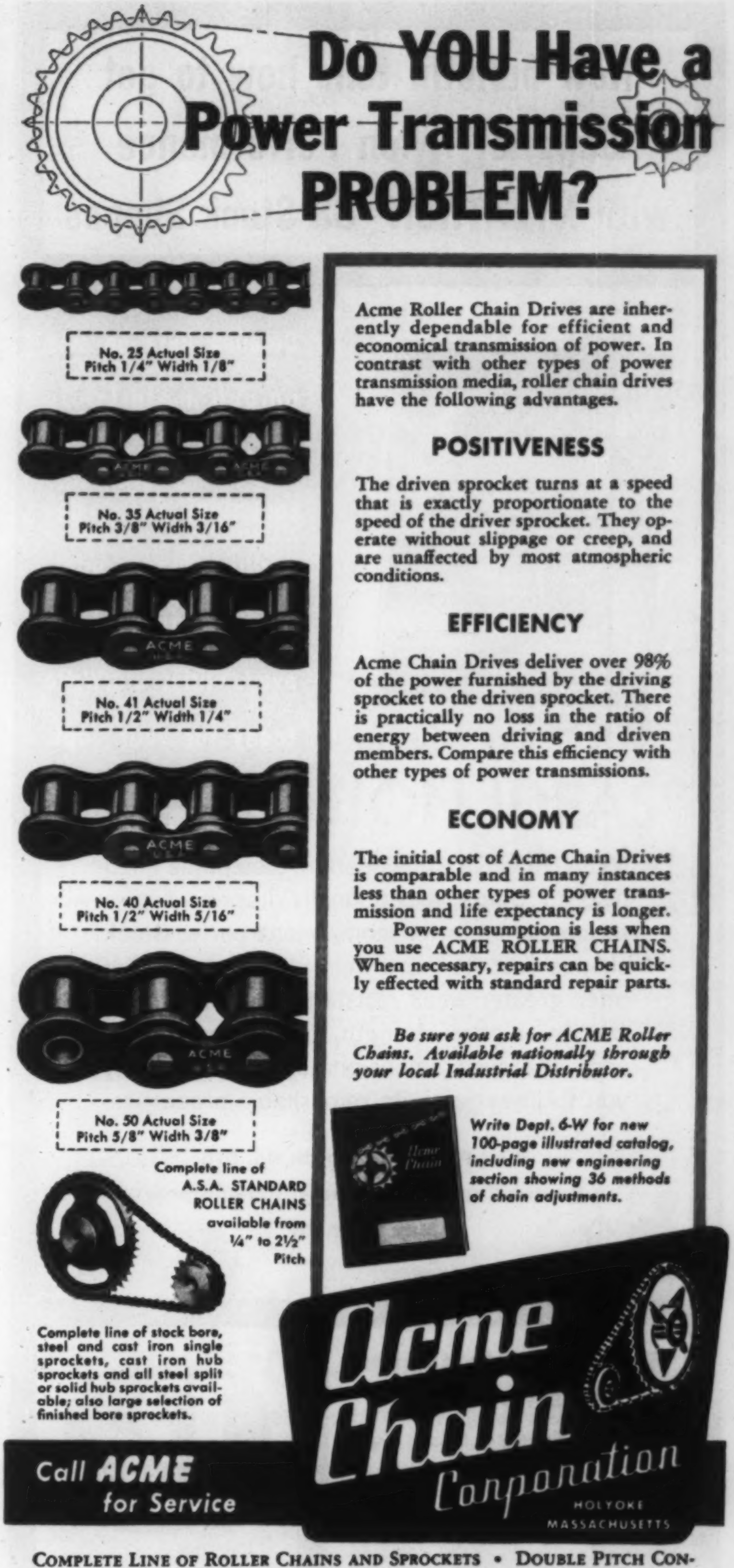
ASME paper 58-A-142, ASME Annual Meeting, New York, December, 1958, 6 pp.

materials

Why Aluminum Power Connections Fail

J. I. Fisher, A. G. Metcalfe, and W. H. Colner, Armour Research Foundation

An evaluation of factors which contribute to failure of aluminum power connections. An experimental connector was designed to permit ready measurement of bolting force, contact resistance, and temperature. Connectors are likely to fail when contact temperatures reach approximately 210 C. A method for giving a connector a theoretical fault current rating was confirmed to some extent in the experiment. It is recommended that every effort should be made to reduce the operating temperature of these connectors. High temperature leads to increased relaxation of the connector, and the mechanical strength of the connec-



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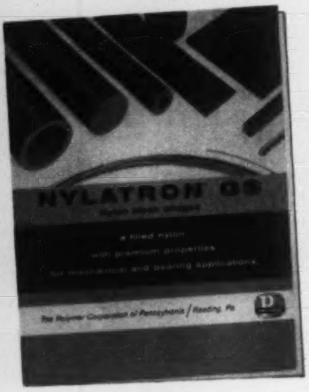

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tion is reduced by any increase in the amount of relaxation.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 15 pp.

Electroplating Magnesium For Electronic Applications

A report on the development of hot-flowed tin electroplating on magnesium. This development means that where weight reduction is important, designers of electronic housings no longer must accept a weight penalty to get good solderability. Soldering and hermetic sealing are more easily accomplished on lightweight magnesium housings than on steel or copper. Tin-plated magnesium is ideal for packaging replaceable and interchangeable electronic components in airborne radar systems, missile-controlled systems, and others. The problem of joining magnesium bases to covers to insure a hermetic seal and to obtain good ground is solved by copper and tin plating and subsequent fusing. The result is improvement in tarnish resistance and solderability. Shelf life is increased and, because of the bright finish, a critical visual inspection is possible. Soldering is easily accomplished with the adherent tin plating and produces a bond which is unusually strong in shear.

From The Magazine of Magnesium, *published by Brooks & Perkins Inc., February, 1959; p. 2.*

Electrical Characteristics of Printed-Circuit Laminates

W. W. Staley and E. V. Burstein, Westinghouse Electric Corp.

Aids in selecting proper laminate materials and processes for critical high-impedance circuits. Data indicate that conventional laminates may not always be satisfactory for applications involving humid environments. Also, attention is called to proper shop handling procedures to avoid contamination of circuits by dust and dirt.

The following conclusions were drawn from the investigation:

1. In applications where high humidity conditions are encountered and critical circuits are involved, Kel-F is the best material to use.
2. Cleanliness of printed-circuit

boards prior to embedment is important. Residual flux is not detrimental but is sticky and picks up contaminants which could cause failure.

3. Insulation resistance of a paper-filled phenolic laminate at high temperatures can be improved by a factor of 15 to 20 by preheating the board before embedment.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 13 *pp.*

Ductile-Fracture Instability In Shear

F. A. McClintock, Massachusetts Institute of Technology

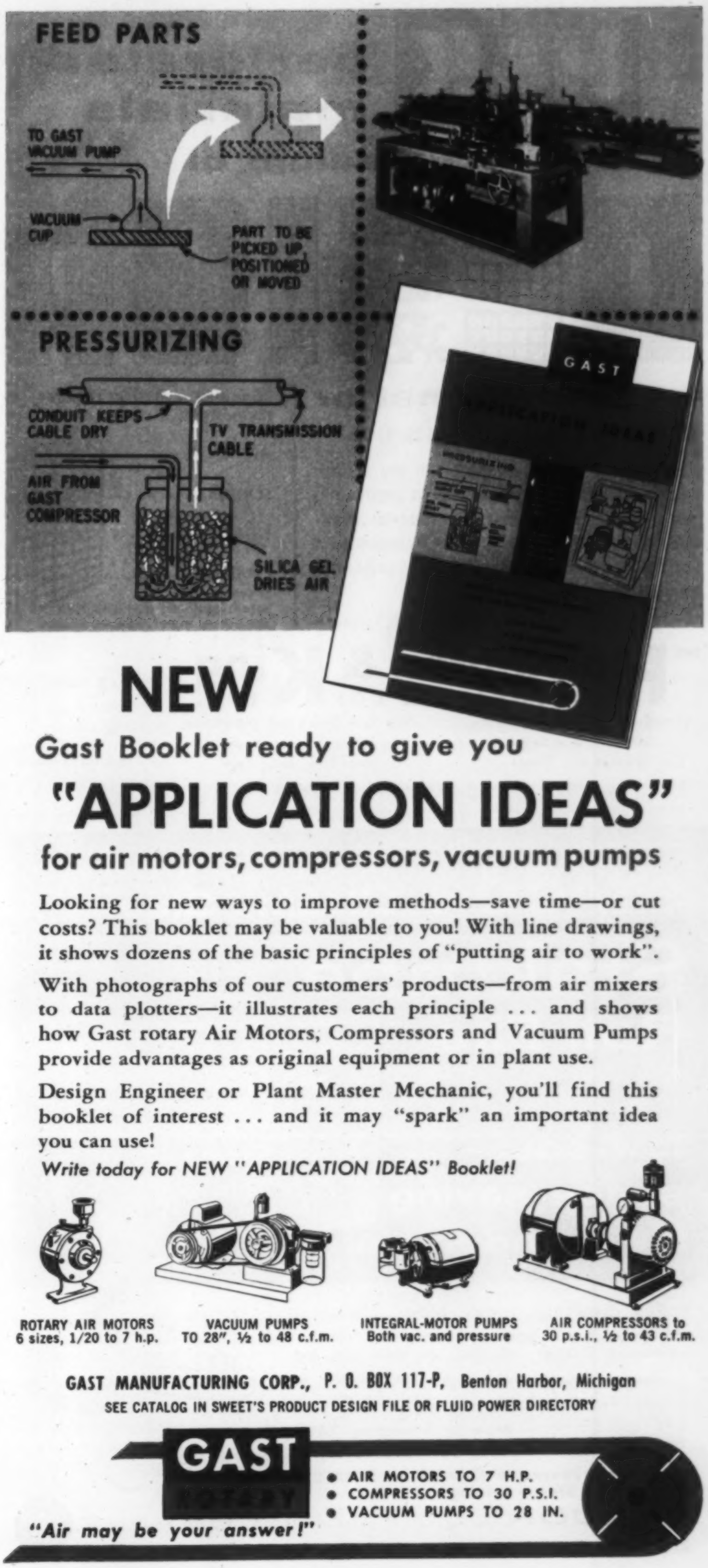
Investigation of the theory that fracture occurs in an elastic-plastic, nonwork-hardening material subject to pure shear when a critical shear strain is obtained throughout a critical volume of material. This theory is combined with classical equations of plasticity to predict when cracking will initiate from a notch at nominal shear stresses below the yield stress, when the crack will become unstable on increase of stress, and when unstable cracking will occur if a notch is cut while a constant nominal stress is maintained. Tests on aluminum foil under biaxial tensile stress show results similar to those predicted by the theory.

ASME paper 58-A-12, *ASME Annual Meeting, New York, December,* 1958; 7 *pp.*

A Mathematical Model Depicting Stress-Strain Diagrams

I. R. Whiteman, General Analysis Corp.

An analysis which shows that a mathematical model may be used to portray stress-strain diagrams and generate hysteresis loops when plastic deformation is experienced. Such a model is significant in the study of fatigue. Since the study is complicated by the many variables associated with it, and because fatigue testing is costly, the model is intended as a transition from physical reality to computer methods. Once a satisfactory mathematical model is obtained which possesses the behavior patterns of real physical specimens, then the model may be tested under the variety of conditions that is of concern in design problems. The tests, how-



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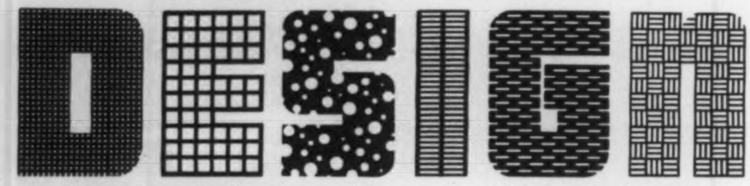

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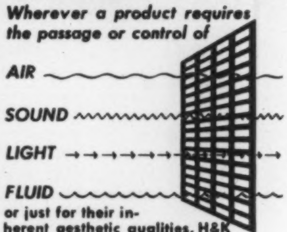

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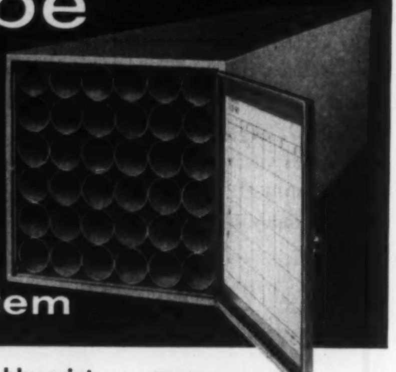

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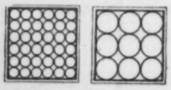

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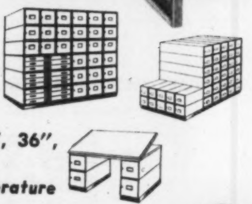

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ever, take place in a computer rather than in a laboratory. To obtain equations of the stress-strain curve and the hysteresis loop, a physical model is postulated which is made up of a number of elastoplastic elements.

ASME paper 58-A-68, *ASME Annual Meeting, New York, December*, 1958; 6 *pp.*

Salt-Spray Corrosion of Simulated Electrical Connectors

M. S. Frant, Amp Inc.

Results of galvanic corrosion tests on 60 metallic connections common in the electrical industry. Wire to crimped-sleeve connections were made in such a way that actual corrosion currents could be measured. Results are presented graphically, and most agree with practical field experience. Aluminum to plain copper, silver-plated copper, or gold-plated copper combinations result in severe corrosion. However, an aluminum to tin-plated copper combination is highly satisfactory. Results apply only to galvanic corrosion and do not consider contact properties.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 4 *pp.*

Reliability of Soldered Joints In Etched-Circuit Assemblies

B. A. Gertheide

Factors which influence reliability of soldered joints. Selection of solder alloys and actual conditions surrounding soldering operations are not the only major concerns for connections. Variations which occur in combination of resin and reinforcing fillers in the laminates themselves must be understood because they affect copper bond strength, blistering, temperature coefficients, and delaminations. All these in turn affect joint reliability. Tabular data show the relationship of solder-joint reliability to resin content. Several laminate materials are evaluated.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 13 *pp.*

Coatings for Contact Surfaces

R. G. Baker, Bell Telephone Laboratories Inc.

Results of a test on electroplated and hot-dip coatings as possible contact materials. Three phases of a program currently under way are reported. So far, results indicate that 24-carat gold coatings, in a thickness of 0.001 in. or greater, are the best plated contact material studied; that copper and phosphor bronze are preferred over 12 per cent nickel brass and yellow brass for use as a basis material for contact; and that 0.0002-in. electroplated solder of a 50-50 lead-tin composition has attractive possibilities. Other phases and results of the tests are covered.

Presented at the Third Electronic Industries Association Conference on Reliable Electrical Connections, Dallas, December, 1958; 16 pp.

Properties of Magnesium And Titanium Alloys

Special charts showing the composition and properties of magnesium castings, extrusions, sheet, and plate, and compositions and producers of titanium mill products. Tables are prepared as removable inserts on special translucent paper which can be reproduced by Ozalid or any blueprint machine.

From The Magazine of Magnesium, *published by Brooks & Perkins Inc., February,* 1959.

mechanical

Optimum Design of Straight-Walled Diffusers

S. J. Kline, D. E. Abbott, and R. W. Fox, Stanford University

A definition of the four common optimum problems in diffuser design. Emphasis is on design considerations, and references to underlying fluid mechanics considerations are given where pertinent. Available studies show that adequate theoretical methods, either exact or approximate, do not exist for predicting over-all flow regime or designing optimum straight-walled diffusers. A survey of literature shows that only two types of data are available: Performance data on recovery and effectiveness, and maps of flow regime to be expected. From these, an empirical scheme is formulated to determine predictions desired. Four different types of problems are defined, and methods of prediction are given for each type.

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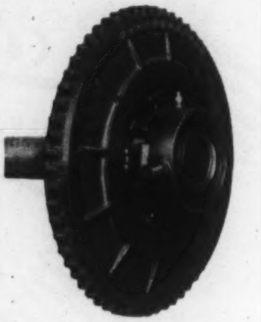

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Flow-regime charts given, together with the method developed for correlating various geometries, allow good prediction of the location of optimium conditions and/or the general type of flow to be expected, assuming reasonable inlet conditions, straight walls, and low Mach numbers. Remarks are included about possible application when these conditions are not satisfied.

ASME paper 58-A-137, *ASME Annual Meeting, New York, December,* 1958; 9 *pp.*

Space Mechanisms

Rudolph Beyer, Technical University, Munich, Germany

A special report on the determination of screw-axes in space mechanisms. Techniques for analyzing motion properties of all types of 3-D mechanisms are surveyed.

Presented at the Fifth Conference on Mechanisms, cosponsored by Purdue University and MACHINE DESIGN, October 13-14, 1958.

Behavior of Bolted, Flanged Joints Under Internal Pressure

M. B. Donald, University College, London, and J. M. Salmon, Foster Wheeler Francaise, Paris

How internal pressure changes the stress system of a narrow-face, bolted, flanged joint. During application of hydraulic pressure to this type of a flanged joint, bolt load can increase, decrease, or remain constant depending upon dimensions and elastic properties of joint components. Bolt load is most likely to increase with a thick or resilient gasket. A thick gasket can, for the same bolt load, contain a lower pressure before leaking than a thinner gasket. Change in bolt load with increase in internal pressure is fortunately small and, if an adequate factor of safety is incorporated in the design, can be neglected.

Increase in bolt length on application of pressure to the joint is equal to the recovery of gasket thickness as the gasket reaction diminishes, less the change in deflection of the flanges between gasket and the bolt circle. The difference between these two quantities may be positive or negative, and bolt length may either increase or decrease as pressure is applied. For a given pair of flanges and set of bolts, change in bolt load depends entirely on the gasket material and its dimensions. With nonelastic materials such as compressed asbestos, modulus of elasticity varies considerably with gasket thickness and load. These factors influence change in bolt load with pressure.

Results of this experiment indicate that there is a linear relationship between bolt load and internal pressure. The slope of the line giving this relationship depends on the elastic properties and dimensions of the components of the joint, and can be predicted mathematically. Rotation of the flange rings due to pressure increases as the slope of the bolt load versus internal pressure line changes from negative to positive. The circumferential strain in the flange and pipe assembly is at a maximum in the pipe at the back of the hub.

Prepared for the Institution of Mechanical Engineers, Westminster, London; 8 pp.

Synthesis of a Four-Bar Mechanism

J. Hirschhorn, New South Wales University of Technology, Sydney, Australia

Application of the "component method" of synthesis of four-bar mechanisms. Particularly, application is to synthesis of four-bar linkages with prescribed extremes of the angular velocity of the driven or output link.

ASME paper 58-A-2, ASME Annual Meeting, New York, December, 1958; 3 pp.

Effect of Product of Inertia Coupling

C. E. Crede, Barry Controls Inc.

Development of a method for determining natural frequencies in three coupled modes. The method is concerned specifically with a rigid body on resilient supports located underneath. The system has a single vertical plane of symmetry. Horizontal translational and rotational motions of the body in one of the vertical planes are coupled, and similar coupling occurs in the other vertical plane. For motion in the horizontal direction perpendicular to the plane of symmetry, the product of inertia of the body causes additional coupling to rotational motion about the vertical axis.

The theory of a rigid body on resilient supports is often used to evaluate performance of vibration

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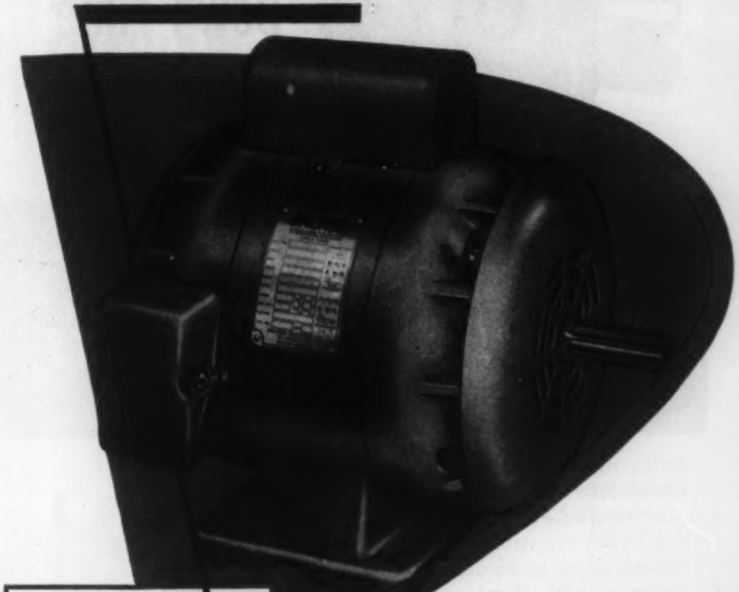

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isolators in many application problems. The general condition involves 6 deg of freedom but, in the absence of symmetry, resulting equations are too cumbersome for practical engineering use. If certain kinds of symmetry are assumed, these equations become sufficiently simple to be useful in a wide range of problems.

ASME paper 58-A-9, *ASME Annual Meeting, New York, December,* 1958; 5 *pp.*

Design and Analysis of Welded Pressure-Vessel Skirt Supports

N. A. Weil and J. J. Murphy, The M. W. Kellogg Co.

Factors determining performance of welded-skirt supports for vertical process vessels. Importance of thermal effects is emphasized. A comprehensive analysis of local stresses with closed-form solutions is presented which permits assessment of expected performance in service on a fatigue basis. Expected shape of skirt distortion is briefly mentioned. Suggestions and recommendations are made for design practice, control of thermal stresses, and weld and fabrication detail for optimum practical quality as dictated by service conditions. A numerical example illustrates application of the analysis.

ASME paper 58-A-153, *ASME Annual Meeting, New York, December,* 1958; 13 *pp.*

Postbuckling Behavior of Rectangular Plates

Norboru Yamaki, Tohoku University, Sendai, Japan

Solution of equations for large deflections of thin plates with slight initial curvature presented for the case of a rectangular plate subjected to edge compression. The problem is solved under eight different boundary conditions and combines two kinds of loading and four kinds of supporting conditions. Numerical solutions are obtained for square plates with and without initial deflection. Results are graphed and discussed.

ASME paper 58-A-59, *ASME Annual Meeting, New York, December,* 1958; 8 *pp.*

Nonlinear Bending of Thin Rods

T. T. Mitchell, Cornell University

Analysis of nonlinear bending of straight and circular-arc cantilevers under vertical and horizontal point loads. Formulas for determining

Circle 541 on Page 19

deflected shape of the cantilevers are presented. Closed-form solutions are obtained for bending under two types of distributed loads. In particular, the problem of bending under a uniformly distributed normal load is solved.

ASME paper 58-A-50, *ASME Annual Meeting, New York, December,* 1958; 4 *pp.*

Creep Deflection of a Rivet in Double Shear

J. Marin, The Pennsylvania State University

Development of an approximate theory for determination of creep deflection of a rivet in double shear in terms of creep constants of the material in simple tension. A basic approach to this problem is theoretically to predict creep behavior of riveted joints from creep and simple tension. Simplifications and assumptions made in this paper give sufficiently accurate results for engineering purposes.

ASME paper 58-A-47, *ASME Annual Meeting, December,* 1958; 6 *pp.*

A Three-Dimensional Photoelastic Study of Stresses

C. E. Taylor, N. C. Lind, and J. W. Schweiker, University of Illinois

A description of the three-dimensional photoelastic determination of stresses around cylindrical outlets in spherical and cylindrical shells loaded by internal pressure. Results are tabulated in the form of stress-concentration factors. Distribution of principal stresses of the surfaces of typical models is included.

ASME paper 58-A-148, *ASME Annual Meeting, New York, December,* 1958; 9 *pp.*

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The Magazine of Magnesium—Brooks & Perkins Inc., 1950 West Fort St., Detroit, Mich.

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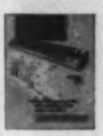

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Circle 542 on Page 19

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the
shape
we
extrude
it!

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specifications

Regardless of the shape, if it can be extruded—Anchor can do it! Anchor is completely equipped to custom-extrude any shape molding, tube, rod or strip . . . in every type plastic, including Polycarbonates, Polypropylenes and Rigid Polyvinyl Chlorides. New horizons are opened by Anchor's Plasti-Brass® molding, like polished brass . . . also in gold, copper, chrome. Write for brochure, "EXTRUDED PLASTICS"

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Booth 1049, May 25-28th
Circle 543 on Page 19

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—Page 19

Selsyns & Synchros

Used for accurate transmission of electrical angular data between two or more points, G-E selsyn and synchro electromagnetic devices are accuracy rated from ±1.50 to ±0.3 degrees. Bulletin GEA-6675 discusses selsyn and synchro generators, motors, control transformers, differential generators and motors, tandem selsyns, and system operation. 16 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 842 on Page 19

Pure Chromium Metal

Produced by an iodide decomposition process, Iochrome pure chromium metal contains no single metallic or gaseous impurity in quantities greater than 10 parts per million. Applications, typical analysis, and fracture and fabricability of metal are covered in Bulletin 30. 4 pages. Chromalloy Corp., 450 Tarrytown Rd., White Plains, N. Y. D

Circle 843 on Page 19

Conveyor & Transmission Belting

Vosstex line of conveyor and power transmission belting includes a complete selection of rubber, neoprene, and Hycar belting for manufacturing and food processing equipment. Belting is described in bulletin. 8 pages. Voss Belting & Specialty Co., 5645 N. Ravenswood Ave., Chicago 26, Ill. I

Circle 844 on Page 19

Corrosion Resistant Condulets

"Condulets for Corrosive Locations" is title of Bulletin 2699 which points up corrosion-resistant properties of various metals and finishes used in Crouse-Hinds condulets. Plast-A-Coat condulets for hazardous and nonhazardous locations are listed as well. 16 pages. Crouse-Hinds Co., Syracuse 1, N. Y. N

Circle 845 on Page 19

Precision Ball Bearings

Data given in Catalog 59 on Featherweight precision ball bearings cover units with 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4, and 1 in. cross section. They are available as either radial, angular contact, or four-point contact bearings. Ratings are given at 100 rpm for 3000 hr average life. 12 pages. Messinger Bearings, Inc., 3727 D St., Philadelphia 24, Pa. E

Circle 846 on Page 19

Appliance Switch

Operating characteristics and ordering information relating to the E13-00A Series snap-action appliance switch are provided in folder. It is offered with leaf, roller leaf, pushbutton, and overtravel pushbutton actuators. 4 pages. Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill. I

Circle 847 on Page 19

Worm Gear Screw Jacks

Dimensional drawings on 5, 10, 12½, and 15-ton rated worm gear screw jacks are found in folder. These mechanical power packages are intended for conveyor adjustment, pressure and torque applications, machine adjustments, leveling systems, welding positioners, jigs, and testing equipment. 4 pages. Joyce-Cridland Co., Dayton 3, Ohio. G

Circle 848 on Page 19

Microwave & Electronic Equipment

Microline microwave and electronic equipment listed in condensed catalog includes field test equipment, weapon system support equipment, microwave ferrite devices, subsystems and antennas, and components. Basic microwave instruments are listed with range, capacity, and accuracy figures. 12 pages. Sperry Microwave Electronics Co., Clearwater, Fla. O

Circle 849 on Page 19

Silicon Diodes & Transistors

Descriptive Brochure QA-60-28-0001 covers construction and reliability of Sperry silicon diodes and PNP transistors. It points up research and development facilities and shows new semiconductor devices. 12 pages. Sperry Rand Corp., Semiconductor Div., South Norwalk, Conn. B

Circle 850 on Page 19

Bellows Seals & Check Valves

Bulletins AS01 and HA02 respectively cover Sealol bellows seals and Sealol check valves for gases, vapors, liquids, and cryogenics. Former tabulates dimensions for all sizes. Latter presents specifications and other data for both soft and hard seat check valves. 4 pages each. Sealol Corp., Providence 5, R. I. B

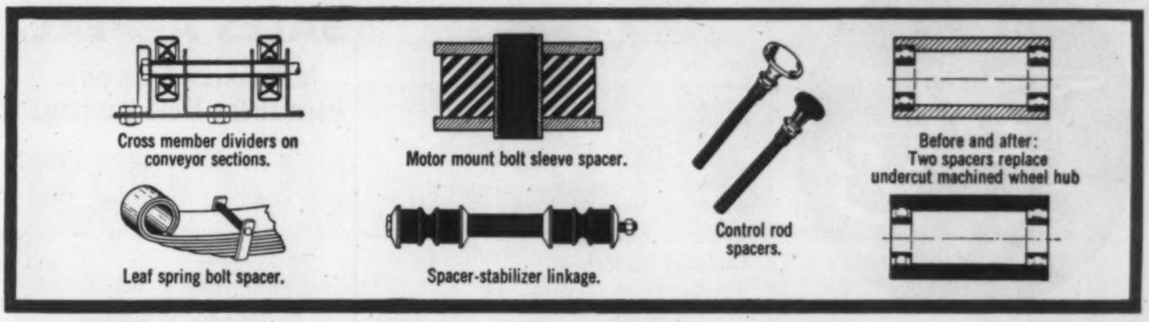
Circle 851 on Page 19

O-Rings & Seals

The Minnesota Rubber Fact Book has been expanded to include installation information, compound data, and other useful material. It provides such information as size numbers and dimensions of all common industrial O-rings and the exclusive Quad Ring. Tips for installation of different seals are also given. 24 pages. Minnesota Rubber Co., 3630 Wooddale Ave., Minneapolis 16, Minn. J

Circle 852 on Page 19

F-M Spacers Save Money in Hundreds of Applications. Spacers shown in Red



Cross member dividers on conveyor sections.

Motor mount bolt sleeve spacer.

Control rod spacers.

Before and after:
Two spacers replace undercut machined wheel hub

Leaf spring bolt spacer.

Spacer-stabilizer linkage.

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Time, Money, Materials with Rolled, Split SPACER TUBES

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This Isomode® Type 5 mount is successfully isolating engine of Allis-Chalmers HD-6 Crawler Tractor. It survives severe shocks, rough motions, distortions, bursts of power and high engine torque inherent in operation of tractor dozers.

With a core in balanced compression and shear, the compact mounts have high load capacity, and are self-snubbing against shocks. Having equal spring rate in all directions, the mounts equally isolate the 6 possible modes of vibratory motion.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A.

MB MANUFACTURING CO.
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1056 State Street
New Haven 11, Connecticut

Circle 545 on Page 19

Iron Bearings

Self-lubricating iron Oilite 212 bearings are suitable for many "bronze" applications where corrosion is not a problem and mechanical strength is within tolerable limits. Folder provides performance data, properties, recommended uses, and other how-to-use information. 4 pages. Chrysler Corp., Amplex Div., Box 2718, Detroit 31, Mich. H

Circle 853 on Page 19

Enclosed Switches

Revised illustrated Catalog 83c gives details of nine housing groups of metal enclosed industrial switches. Explosionproof, maintained-contact, prewired, hand operated, and sealed types are among the 99 listings. Specifications of all models are given. 20 pages. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill. K

Circle 854 on Page 19

Flexible Couplings

Standard and special bonded rubber flexible couplings are detailed in illustrated Bulletin 205. Specifications are given for three standard shear type couplings, rated 1/50 to 100 hp at 1750 rpm. Selection formula is presented. 6 pages. Lord Mfg. Co., 1635 W. 12th St., Erie, Pa. F

Circle 855 on Page 19

Tubing, Pipe & Fittings

High temperature properties, chemical composition, size ranges, and short time tensile and rupture properties of Croloy 16-13-3 stainless tubing, pipe, and welding fittings are found on Technical Data Card 189. 2 pages. Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. G

Circle 856 on Page 19

High Temperature Locknuts

High strength and light weight are combined in FN 1216 locknuts, subject of Form 2468. Minimum tensile strength at room temperature is 160,000 psi, and over 140,000 psi at 1200° F. Design features and technical data are given. 4 pages. Standard Pressed Steel Co., Box 102, Jenkintown, Pa. C

Circle 857 on Page 19

Induced Draft Fans

Specifications, design features, and advantages of a line of induced draft fans are among content of illustrated Bulletin L-3. Dimensioned drawings and charts of ratings are included, along with recommendations for specific applications. 16 pages. Fuller Co., Lehigh Fan & Blower Div., Catasauqua, Pa. E

Circle 858 on Page 19

Heat Resistant Finish

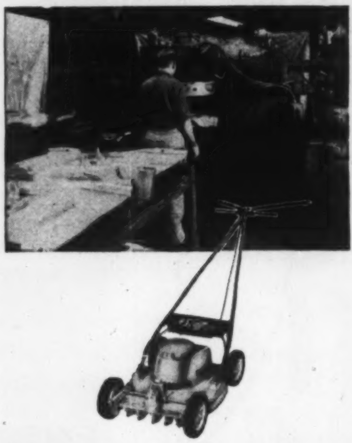
Silicone base Sicon finish, heat stable up to 1000° F, is subject of illustrated folder. Properties, characteristics, and application data are included. Products using it are shown. 4 pages. Midland Industrial Finishes Co., E. Water Street, Waukegan, Ill. J

Circle 859 on Page 19

RUGGED SALES APPEAL

In Monarch Aluminum Permanent Mold Castings

Monarch's "One Source" analysis of their end-product casting requirements enabled O. M. Scott & Sons Company to compare all casting methods before freezing final design. Monarch engineers helped determine that aluminum permanent mold castings would produce the best end-product performance.



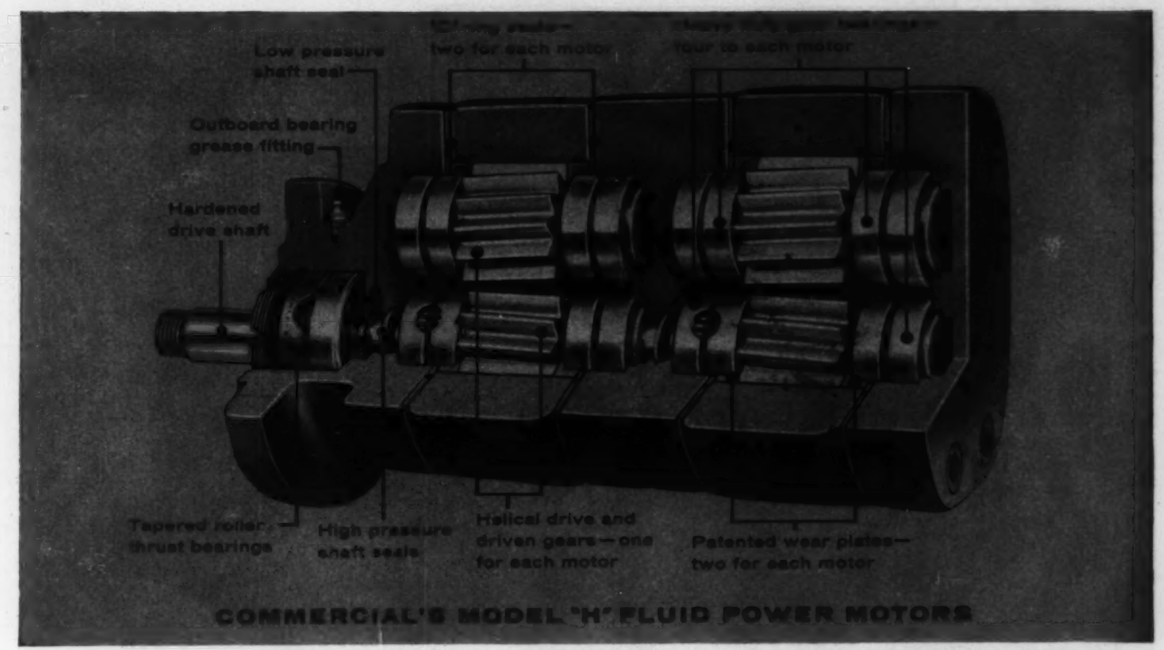
Monarch's extensive services in casting, machining and finishing provided completed castings ready for Scott's assembly.

This is a typical example of Monarch's approach to more casting value per dollar. It is underwritten by vast experience in mass-production of aluminum permanent mold, aluminum die casting, zinc die casting—machining and specialized finishing. For details how it works write for our new brochure—Today.

MANUFACTURING ACHIEVEMENTS in MOLTEN ALUMINUM

MONARCH ALUMINUM MFG. COMPANY
9205 Detroit Avenue Cleveland 2, Ohio

Circle 546 on Page 19


Low pressure shaft seal
two for each motor
four to each motor
Outboard bearing grease fitting
Hardened drive shaft
Tapered roller thrust bearings
High pressure shaft seals
Helical drive and driven gears—one for each motor
Patented wear plates—two for each motor
COMMERCIAL'S MODEL "H" FLUID POWER MOTORS

New ideas in fluid power motors

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. One single motor having three-inch gears operating at 1600 psi at a speed of 1200 rpm would develop about 50 h.p. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is technical help and assistance from Commercial on fluid power applications.

Address inquiries to The Commercial Shearing and Stamping Company, Dept. S-20, Youngstown 1, Ohio.

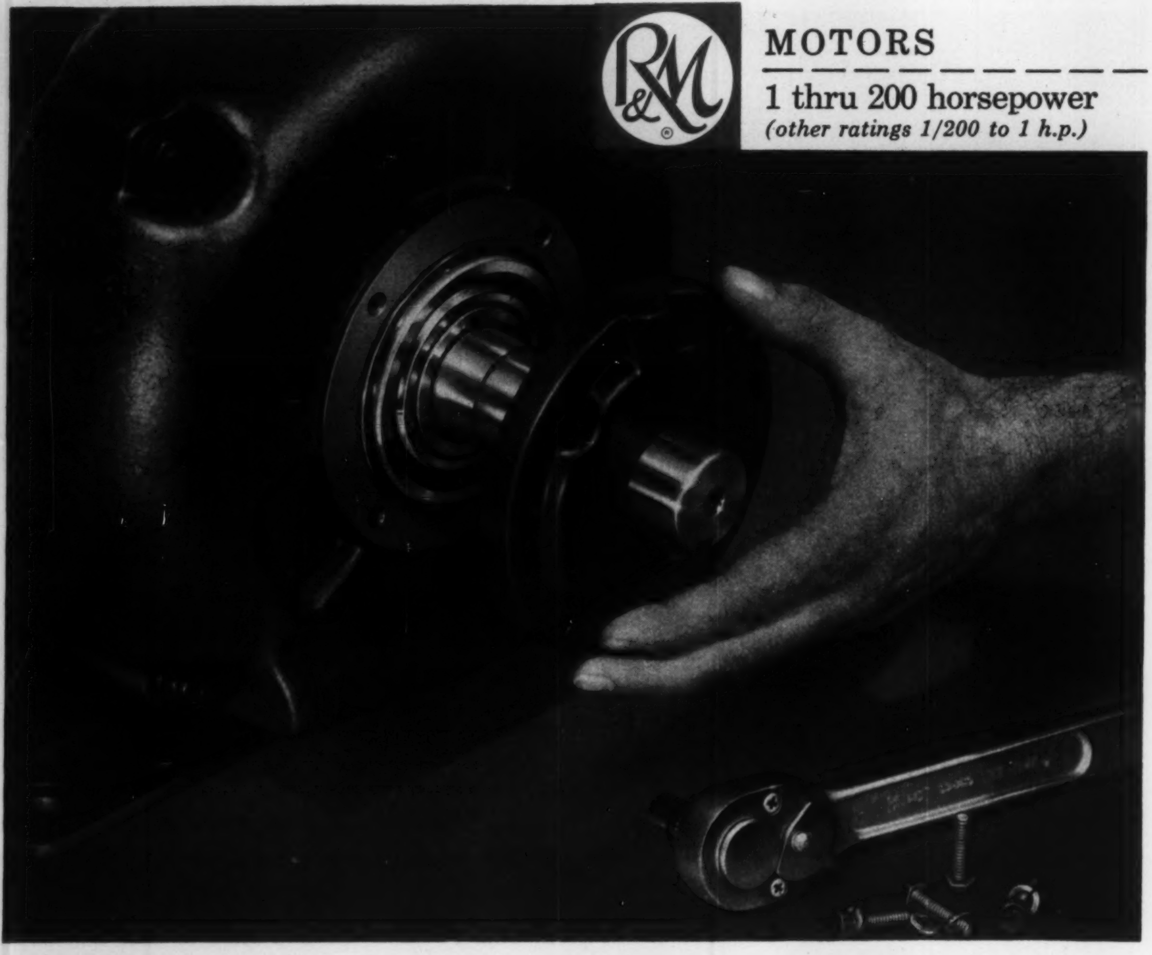
COMMERCIAL
shearing and stamping

Circle 547 on Page 19

MOTORS

1 thru 200 horsepower

(other ratings 1/200 to 1 h.p.)



"*On-the-Job*" Bearing Inspection and Relubrication are Easy!

ROBBINS & MYERS motor bearings are fully sealed and pre-lubricated to operate for years without attention of any kind. However, when maintenance schedules call for bearing inspection and relubrication at shorter intervals, R&M motors cut downtime and save labor expense by making these inspections easy. The bearing cap on each end head comes off quickly when the four securing bolts are removed. The bearing seal, held in place by removable snap rings, likewise, is easily removed to expose the interior of the bearing.

Easily removable bearing caps are only one of R&M's many desirable design features. Double width bearing races have extra-large grease capacity . . . Mylar* insulation that has 8 times the dielectric strength and 35 times more moisture resistance than ordinary paper insulation . . . end heads offer full-height protection . . . dual-sweep ventilation assures efficient cooling. For details, write today for Bulletin 520 MD

**DuPont registered trademark*

Mylar slot insulation
protected end heads

ROBBINS & MYERS, INC.

motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

SPRINGFIELD, OHIO · BRANTFORD, ONTARIO

Microfilm Reader

The Designer 184, an 18 x 24-in. microfilm reader for engineering drawings, is subject of an illustrated folder. Its technical details are presented. 4 pages. Filmsort Co., Pearl River, N. Y. D

Circle 860 on Page 19

Leaded Steel Forgings

Case histories, along with mechanical property and machining tests for Hi-Qua-Led leaded steel forgings are found in detailed guide book. Machining data are included, as are many charts, graphs, and photomicrographs. Forgings are offered in forged and rolled rings from 18 to 145-in. OD and open die shapes from 1000 to 36,000 lb up to 40 ft long. 40 pages. Alco Products, Inc., Box 1065, Schenectady, N. Y. C

Circle 861 on Page 19

Speed Reducers

Line of All-Motor and integral Motoreducers is detailed in revised Bulletin 3100. Both designs use standard NEMA motors. Information on unit size and construction, how to select the proper size and ratio, typical installations, and accessories is included. A table lists load classifications by application. 28 pages. Falk Corp., Box 492, Milwaukee 1, Wis. K

Circle 862 on Page 19

Control Panels

Automatic control panels built to specifications are illustrated in Pantro folder. Units assembled for several diverse industries are shown. 4 pages. Control Panel Corp., 517 W. Monroe St., Chicago 6, Ill. J

Circle 863 on Page 19

Stainless Steel

Comparative corrosion resistance of Type 302, 316, and 430 stainless steels and Type 1100 aluminum are presented in table form in the "Microrold Stainless Steel Handbook." Physical properties, analyses, surface finishes, fabrication, and maintenance data are covered for stainless sheet and strip grades. 36 pages. Washington Steel Corp., Washington, Pa. G

Circle 864 on Page 19

Spur Gears

Ultra-high precision, fine pitch master spur gears carried in stock are subject of Catalog 158. Required AGMA tolerances are compared with their tolerances. Specifications for all gears are included. 8 pages. Invo Spline, Inc., 2357 E. Nine Mile Rd., Hazel Park, Mich. H

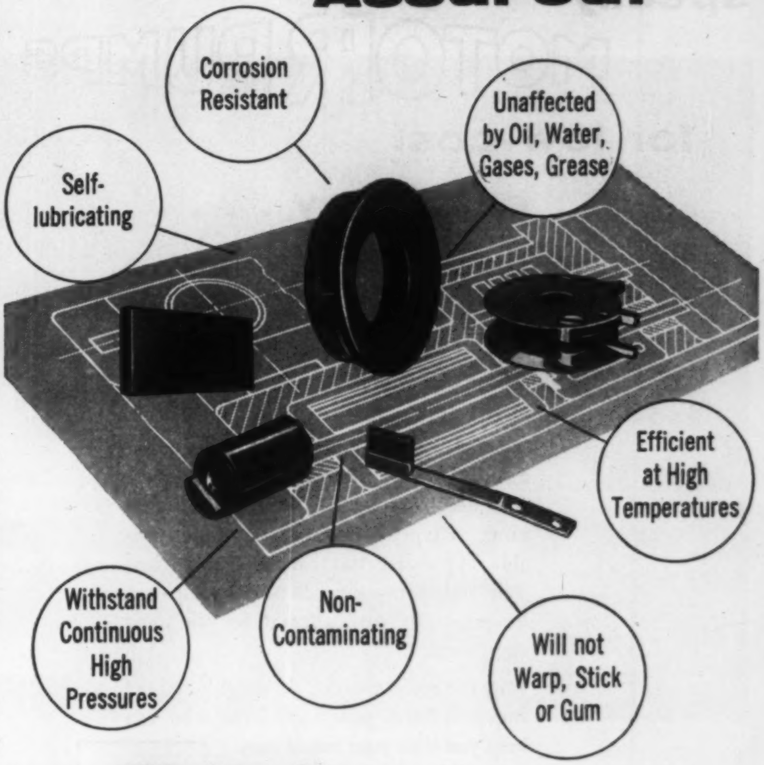
Circle 865 on Page 19

Cold Rolled Spring Steel

Available sizes, weights, and hardnesses of a variety of Swedish cold rolled spring steels are given in "Stock List." Among them are blue tempered and polished clock spring, band saw, tempered flapper valve, and shock absorber, thickness gage, and annealed spring steels. 44 pages. Uddeholm Co. of America, 155 E. 44th St., New York 17, N. Y. D

Circle 866 on Page 19

DESIGN FLEXIBILITY Assured!


Corrosion Resistant
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Self-lubricating
Efficient at High Temperatures
Withstand Continuous High Pressures
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Morganite has the answer to countless hard-to-solve design considerations. Its many inherent electro-mechanical advantages afford engineers extremely wide latitude and a high degree of flexibility. For example, self-lubricating Morganite bearings are ideal for incorporation in sealed mechanisms. Radar contacts of Morganite are employed in critical military and commercial systems because of exceptional dependability over a wide range of temperatures. For suggestions on your design problems, just call or write, Morganite!

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Circle 549 on Page 19

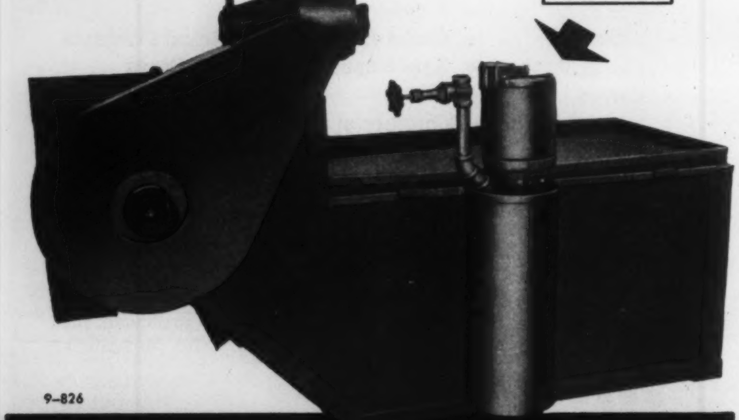
machinery builders
specify
MOTORPUMPS
for low-cost
efficiency . . . .

Their long record of dependability and efficiency . . . their many design features . . . their adaptability to many types of machines, has proved that Ingersoll-Rand Motorpumps offer advantages not found in any other pump.

Whatever your liquid handling requirements, there is a Motorpump that can meet your needs exactly. Select from the widest range of types, sizes and mountings available anywhere. You can save important time and money because Motorpumps are designed for easy adaptability to most equipment.

Why not consult with a thoroughly trained Ingersoll-Rand pump specialist who can help you with your liquid moving problem. Call your nearest I-R branch office or write for complete information.

A magnetic separator in which an Ingersoll-Rand immersion type Motorpump has been incorporated.



9–826

Ingersoll-Rand 11 Broadway, New York 4, N. Y.

Coated Tubings

Silicone rubber coated, silicone varnished, and varnished glass cloth; varnished rayon; and vinyl coated glass cloth tubings are described in catalog. Physical and electrical data and application information are given, along with other facts. 6 pages. Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. J

Circle 867 on Page 19

Utility Pumps

Helical screw which turns in a tough rubber stator is only moving part in the utility pumps detailed in illustrated Bulletin CP-3489. They are self-priming to as much as 25 ft of suction lift. Capacities range to 50 gpm and 150 psi. 8 pages. Continental Pump Co., 1027 S. Vandeventer Ave., St. Louis 10, Mo. I

Circle 868 on Page 19

Aircraft Control Parts

Series of four Data Sheets No. 105-3, 119-6, 119-7, and 119-8 describe four products for automatic flight control systems. They are flexible drive shaft, bypass and shut-off valve assembly, demand pressure regulator, and differential pressure transducer. 2 pages each. Lear, Inc., Grand Rapids Div., 110 Ionia Ave. N.W., Grand Rapids 2, Mich. H

Circle 869 on Page 19

Flow Control Valves

Floreg valves for flow control of gases and liquids are illustrated and their features listed on Data Sheet D6-105.01. They work with other components to time, sequence, or coordinate the operations of a circuit. 2 pages. Westinghouse Air Brake Co., Industrial Products Div., Box 36, Wilmerding, Pa. G

Circle 870 on Page 19

Substation Transformers

Single and three-phase substation transformers up to and including 10,000 kva, through 69 kv are detailed as to construction features, and standard and optional accessories in Bulletin CS-701. 8 pages. Kuhlman Electric Co., Birmingham, Mich. H

Circle 871 on Page 19

Counting Devices

Various types of impulse counting devices are subject of condensed catalog. Data are given on manual and electric reset counters; monodecade counters; hours, minutes, and seconds indicators; predetermining counters; and impulse adapters. 4 pages. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y. D

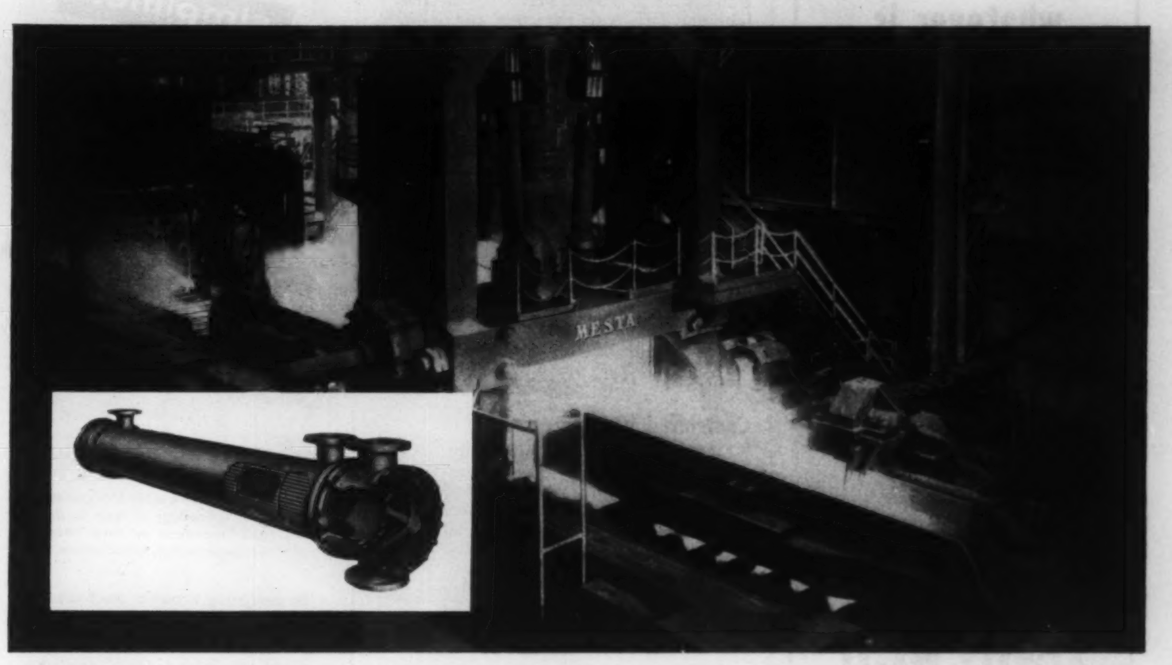
Circle 872 on Page 19

Water Temperature Controls

Self-operating temperature regulators, air or water operated regulators, air or water operated diaphragm valves, steam and water mixers, dial thermometers, and thermostatic water mixing valves are described in Catalog WC on water temperature control equipment. 24 pages. Powers Regulator Co., Skokie, Ill. I

Circle 873 on Page 19

lube oil cooled by Ross Exchangers



Blazing ingots thinned to glowing slabs

in this Mesta Mill

HEAVY SHOCK LOADS, scorching heat and continuous operation — they're all part of the job as this Mesta Universal Reversing Slabbing Mill rolls red hot steel ingots into slabs.

UNDER THESE SEVERE conditions where working temperatures of gears and bearings will often exceed 200°F., temperature-safe lubrication is a prime requirement. Even a lubrication failure at a minor point could shut down the entire mill.

THAT'S WHY Mesta selected two Ross Type CP Exchangers to provide dependable cooling of the circulating oil. Roll neck bearings, main drive gears and all hard working parts are given continuous protection by oil at the right temperature and right viscosity.

THROUGHOUT the metal industry, Ross Exchangers are counted on to safeguard the performance of engines, compressors, extrusion presses, metal drawing presses, welders, die casting machines, speed changers and other prime equipment. They're top-rated for thermal efficiency and ruggedness.

COMPACT IN DESIGN, easy to install and easy to maintain, Ross Exchangers are pre-engineered and fully standardized in a wide range of sizes to meet your heat transfer requirements.

For detailed information, send coupon below requesting Bulletin 2.1K5.

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Please send, without obligation, your Bulletin 2.1K5 describing Ross Type CP Exchangers.

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Circle 551 on Page 19

Features that set them apart from whatever is "second-best"!

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Cutaway view of TRE Male Rod End.

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SPHERICAL BEARINGS & ROD ENDS

Quality SPHERCO Bearings and Rod Ends are precision built for superior performance. They are available in a wide range of sizes of varying design and materials to meet specific requirements. A SPHERCO engineer in your area will be happy to help you with your problems.

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Circle 552 on Page 19

Plasma Arc Plating

Use of the Plasma Arc torch which operates at up to 30,000° Kelvin to coat and fabricate parts with refractory and other metals is described in illustrated booklet "Linde Plasmarc Plating." Among metals applied are tungsten, molybdenum, zirconium, tantalum, and stainless steel. 8 pages. Linde Co., 30 E. 42nd St., New York 17, N. Y. C

Circle 874 on Page 19

Titanium Alloy

Titanium alloy MST 881 extends useful temperature range of these alloys to 1100° F for long-time applications and 1600° F for short-time uses. Its tentative mechanical properties, temperature data, stability, forging, annealing, and other facts are presented in Technical Data Sheet. 10 pages. Mallory-Sharon Metals Corp., Niles, Ohio. G

Circle 875 on Page 19

Controlled Volume Pumps

Controlled volume miniPumps for chromatographic analyses will meter as little as 3 ml per hr with accuracy of ±2 per cent. Bulletin 1257-1 contains specification on laboratory, industrial, and chromatographic pump designs. Maximum capacity is 7880 ml per hr against 1000 psi pressures. 4 pages. Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa. E

Circle 876 on Page 19

Contract Manufacturing

The 84-year-old Contract Service Division of this company is described in Catalog 814. Its scope of activity includes individual design, toolmaking, machining, heat treating, production, assembly, and inspection. It lists all the tool and equipment facilities and highlights specific projects which have been successfully completed. 8 pages. Taft-Peirce Mfg. Co., Woonsocket, R. I. B

Circle 877 on Page 19

Carbon Black in Rubber

Reprinted from a national engineering publication, material in available booklet covers "The Dispersion of Carbon Black in Rubber and Its Role in Vulcanizate Properties." Text discusses studies made with electron microscope and contact microradiograph by Columbian Carbon Co. research men. 40 pages. Philips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mount Vernon, N. Y. D

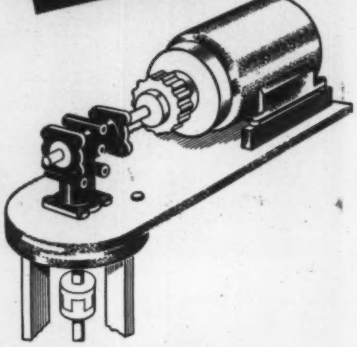
Circle 878 on Page 19

Industrial Equipment

Typical installations for spray, dip, or flow coating finishing systems; cleaning, pickling, and rustproofing; spray booths; drying and baking; dust collection and fog filtration are pictured in industrial equipment Catalog A-659. Booklet stresses the planning, engineering, and coordination of system with respect to products processed and type of finish applied. 12 pages. R. C. Mahon Co., E. Eight Mile Road, Detroit 34, Mich. H

Circle 879 on Page 19

ANGLgear® simplifies power package design



Drawing based on photo shows ANGLgear power takeoff on power package for liquid tar pump. ANGLgear's compactness and 4-way mounting simplified design of unit, helped reduce size.

In designing a power package for a portable tar pump used in roofing work, Continental Cleveland Corp., Cleveland, Ohio, needed a simple, compact 90° power takeoff to stand rough service and handle heavy transmission loads.

A Model R-340, 5 hp ANGLgear met these requirements perfectly. Because of its compactness and 4-way mounting feature, it was easily designed into the power train and helped reduce the size of the entire power unit. It also had the necessary stamina to absorb the loads involved in pumping liquid tar to heights up to 90 ft. Completely enclosed, it could not be fouled by the tar.

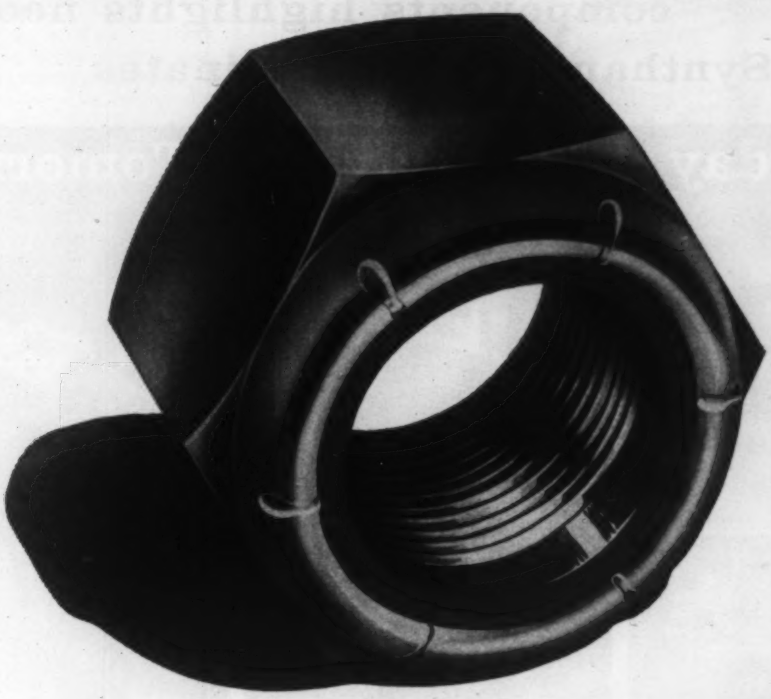
Perhaps ANGLgear can solve a 90° drive problem for you. Designed for manual or power operation, ANGLgears are available from stock in 1/3, 1, 2¼ and 5 hp ratings, with 2 or 3-way shafting, and 1:1 or 2:1 gearing.

See our literature in Sweet's Product Design File or contact your local distributor.

AIRBORNE®
Engineered Equipment for Aircraft and Industry
AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

Circle 553 on Page 19

How many times can this nut be re-used?



ON ANY BOLT OF STANDARD QUALITY, THE NYLON INSERT ELASTIC STOP® NUT PROVIDES DEPENDABLE LOCKING TORQUE

for over 50 on-off cycles

The remarkable wear resistance of the tough nylon collar plus its elastic recovery characteristic make it possible to remove and re-use the standard Elastic Stop nut at least fifty times. This familiar red collar—an integral part of an Elastic Stop nut—grips the entering bolt threads with a perfect fit which dampens impact loads and resists turning under the most severe conditions of vibration and shock. When the nut must be removed for routine maintenance, the nylon collar tends to resume its original shape and, on re-installation, grips the bolt threads as effectively as on the original installation.

Prove it to yourself! Check the coupon for a copy of Recommended Test Procedure for Determining Re-usability.

Re-usability is just one of the advantages of the nylon insert Elastic Stop nut. The constant torque that locks the nut at any position on the bolt: the inertness to gasolines, oils, salt atmospheres, cleaning compounds and common acids: the easy identification on the assembly line or in the field: the one piece construction that simplifies installation and reduces cost—these special features have made the Elastic Stop nut the standard of industry for tough applications.

Elastic Stop nuts are available in thin and regular height hex types in sizes ranging from a watchmaker's 0-80 through 3 inches, also many special shapes to meet your unusual design problems. In standard finishes and materials including carbon and stainless steels, brass, duronze and aluminum.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA
TRADE MARK

See the
NEW VARIGRIP
quick release fastener
AT BOOTH 309
Design Engineering Show
Philadelphia

Elastic Stop Nut Corporation of America
Dept. S31-54, 2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

- ☐ Recommended Re-usability Test Procedure
- ☐ Bulletin No. 5901 showing stop nut design applications on heavy-duty equipment.
- ☐ ESNA condensed hex nut catalog No. 706.

Name____________________

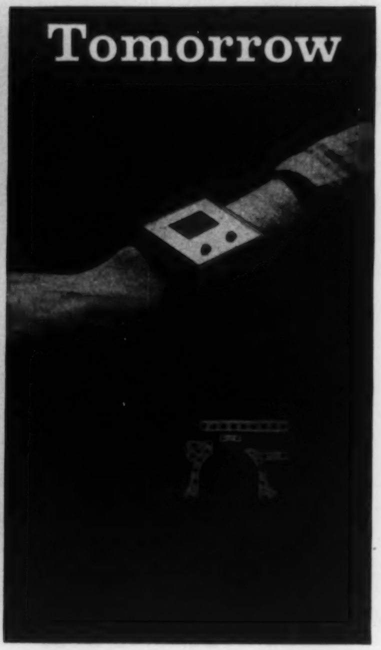
Title____________________

Firm____________________

Street____________________

City__________ Zone____ State______

Miniaturization of electronic components highlights need for Synthane plastic laminates



The tremendous increase in miniaturized electronic components emphasizes a need for the combined properties of Synthane laminated plastics.

Miniaturization, as you know, reduces the insulated path between terminals or conductors, placing a premium upon the insulation resistance of the laminate.

Printed Circuitry Adds to Problem

Printed circuitry, the development that made so many miniature circuits possible, also magnifies the insulation resistance problem because there is a temptation to save space by shortening the distance between conductors. And often the insulation resistance requirement is complicated by printing on both sides of the laminated circuit board.

Test for insulation resistance as conducted by Synthane Corporation.

Other Properties Influence Choice of Laminates

There are many other properties of a laminate which help to make miniaturization practical. For example, miniaturization brings the holes for terminals closer together, a result usually accompanied by a reduction in the size of holes. Punchability of the laminate, therefore, becomes an important consideration. Mechanical strength, after punching, is also worth attention.

In addition, climatic conditions greatly affect electronic equipment. Frequently, laminated plastics must retain their excellent characteristics even under the influence of heat, cold and change of humidities.

Choice of a Synthane laminate with good insulation resistance will finally rest upon the atmospheric conditions of the application, mechanical, electrical and chemical properties required, and, to a degree, upon the economics of the situation.

Synthane Laminates for Insulation Resistance

Usually high insulation resistant Synthane laminates for printed circuits are processed with selected core and surface sheets to obtain the proper balance of electrical and moisture resistance values and to provide an excellent bonding surface for the metal foil.

Synthane Grades G-10 and G-11 (glass epoxy grades) are the top plastic laminates for insulation resistance. G-11 is the stronger flexurally at elevated temperatures. Synthane Grades XXXP, XXXP-IR and P-25 have very good insulation resistance, and are easier to machine and cost less than the epoxy grades. Grade P-25 may be cold punched. Where there must be high impact strength as well as good insulation resistance Grade N-1 may be the logical choice.

Applications: Among the high insulation resistance applications of Synthane laminates are wiring cards for computers, printed circuits for television, switch rotors, automation circuits, automobile dashboard wiring.

You are urged to write directly to us or to call in a Synthane representative for help in choosing the proper grade for your application.

SYNTHANE
S
CORPORATION, OAKS, PENNA.
Laminated Plastics for Industry
Sheets, Rods, Tubes, Fabricated Parts
Molded-laminated, Molded-macerated

Wood Products

"Solving Problems in Wood" is title of brochure which reviews the physical plant facilities of this woodworking plant. It pictures wood structures for seating, case goods, institutional and kitchen use, furniture and architectural corestock, industrial wood parts, and laminates for exterior use. 28 pages. Gamble Brothers, 4601 Allmond Ave., Louisville 9, Ky. G

Circle 880 on Page 19

Actuators & Control Components

Bulletin 1300 gives brief technical description of electric actuators, 28-v and 400 cycle motors, screwjacks, gearboxes, and control equipment for aircraft, missile, ordnance, marine, and industrial applications. All products feature modular construction. 8 pages. Hoover Electric Co., 2100 S. Stoner Ave., Los Angeles 25, Calif. G

Circle 881 on Page 19

Shaft Seals

Series of Cartriseal rotating shaft seals is described in detail in several folders and data sheets. Rotors are made to meet specific needs. Floating mechanical labyrinth, grommet, bellows, and double face types of seals are covered. Cartriseal Corp., 3515 W. Touhy Ave., Lincolnwood, Ill. I

Circle 882 on Page 19

Small Motors

Performance characteristics are clearly shown in chart in Bulletin F-9256 on the Type AYAE shaded-pole motor when it is used as a tachometer generator. 2 pages. Barber-Colman Co., Rockford, Ill. K

Circle 883 on Page 19

Clutch-Pulley Package

Offered in sizes for mounting directly on 1 to 25-hp electric motors, Electro-Sheaves detailed in Brochure WEB P-52 are packaged clutch pulley units. These easily installed units provide direct, instant load control for any belt driven machine. 10 pages. Warner Electric Brake & Clutch Co., Beloit, Wis. K

Circle 884 on Page 19

Electron Tubes

Traveling wave tubes and CW amplifier, pulsed amplifier, reflex oscillator, and multiplier klystrons are subject of condensed catalog entitled "Electronic Tubes." Application and performance data are given. 12 pages. Sperry Rand Corp., Great Neck, N. Y. D

Circle 885 on Page 19

Track Wheels & Rollers

Catalog 34 contains stock list of track wheels and rollers used on materials handling equipment, industrial cars, trippers, larries, and conveyors. Latest list covers single and double-flange track wheels, face-track wheels, and self-oiling, single-flange wheels in diameters up to 36 in. C. O. Bartlett & Snow Co., 6200 Harvard Ave., Cleveland 5, Ohio. G

Circle 886 on Page 19

Design Uniform lift into equipment with DUFF-NORTON WORM GEAR JACKS

Many designers find a ready answer to precise control of linear motion in machinery or equipment with built-in Duff-Norton Worm Gear Jacks.

They are used singly, in tandem and in multiple jacking arrangements to position loads weighing from a few hundred pounds to as much as several hundred tons.

When connected in tandem or groups of four, six or more, these jacks always raise or lower in exact unison regardless of load distribution. They are also used for application of pressure, to push or pull and as linear actuators.

Duff-Norton Worm Gear Jacks are self-locking and will hold heavy loads in position indefinitely without any creep. Since there is no fluid or air to leak, the action is always positive and maintenance is no problem.

These jacks are available in eight standard models with capacities ranging from 2 to 100 tons and with standard raises from 6 to 24 inches. Special raises can also be furnished.

To learn more about how Duff-Norton Worm Gear Jacks may be used in your equipment, send for the bulletin which shows engineering drawings of jacks, Duff-Norton Mitre Gear Boxes and typical applications. Ask for AD-66v.

Visit Design Show Booth 1137

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

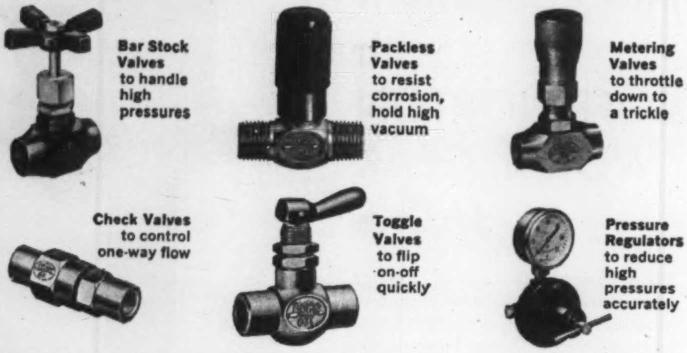
D
DUFF-NORTON
N

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

Circle 557 on Page 19

Industry's big **DEMAND** for small valves keeps growing every day. A few years ago, Hoke's old plant was more than adequate... the product line was limited to a handful of styles. But along came nuclear energy and mass spectrometry and automation. So our lines grew and grew.

HOKE now manufactures:


Bar Stock Valves to handle high pressures
Packless Valves to resist corrosion, hold high vacuum
Metering Valves to throttle down to a trickle
Check Valves to control one-way flow
Toggle Valves to flip on-off quickly
Pressure Regulators to reduce high pressures accurately

Plus many other types, too. And we're not only making more, we're making them faster...with every Hoke Valve leak tested...in our new automated plant.

When you need **QUALITY** small valves, delivered promptly, tell us your requirements. We'll gladly send you our catalog with specific recommendations.

See our Catalog in Sweet's Product Designer's File

Hoke Incorporated,
91 Piermont Rd., Cresskill, N.J.

HOKE

Circle 558 on Page 19

Induction Motors

Squirrel-cage induction motors carried in stock are listed in data sheet which also gives prices and NEMA frames. Capacities range from ¼ to 25 hp. Also listed are 1/6 to 7½-hp totally enclosed single-phase motors. 2 pages. Baldor Electric Co., 4353 Duncan Ave., St. Louis 10, Mo. I

Circle 887 on Page 19

Pressure Reducing Valve

Cutaway view, operating principles, and performance information on a sliding-gate pilot-operated pressure reducing valve for steam, water, oil, gas, air, or chemical service are contents of Bulletin J-1160. 4 pages. Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio. G

Circle 888 on Page 19

Nuclear Graphite

Technical data on manufactured graphite for nuclear applications are furnished in Catalog Section S-4905. It points up graphite's low neutron absorption cross section, high temperature strength, corrosion and thermal shock resistance, and high thermal conductivity. 8 pages. National Carbon Co., 535 Fifth Ave., New York 17, N. Y. C

Circle 889 on Page 19

Magnetic Amplifiers

Usable in 60 or 400-cycle systems with either proportional direct current or alternating current output, a new line of low level, linear, magnetic amplifiers is detailed in Bulletin S-921. They are suited for military and industrial needs. 2 pages. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. D

Circle 890 on Page 19

Vertical & Roll Files

Space saving means of filing and protecting plans, blueprints, maps, drawings, and other large sheets, as well as smaller materials, are provided by Plan Hold vertical and roll filing equipment. Available units are described and illustrated in Catalog 4-59. 12 pages. Plan Hold Corp., 5204 Chakemco St., South Gate, Calif. L

Circle 891 on Page 19

Speed Reducers

Engineering information and specifications on the SpeedMaster line of vertical-helical speed reducers are presented in illustrated Bulletin 5908. Both double and triple reduction units are covered and selection instructions are included. 16 pages. Western Gear Corp., Box 126, Belmont, Calif. L

Circle 892 on Page 19

Selenium Rectifiers

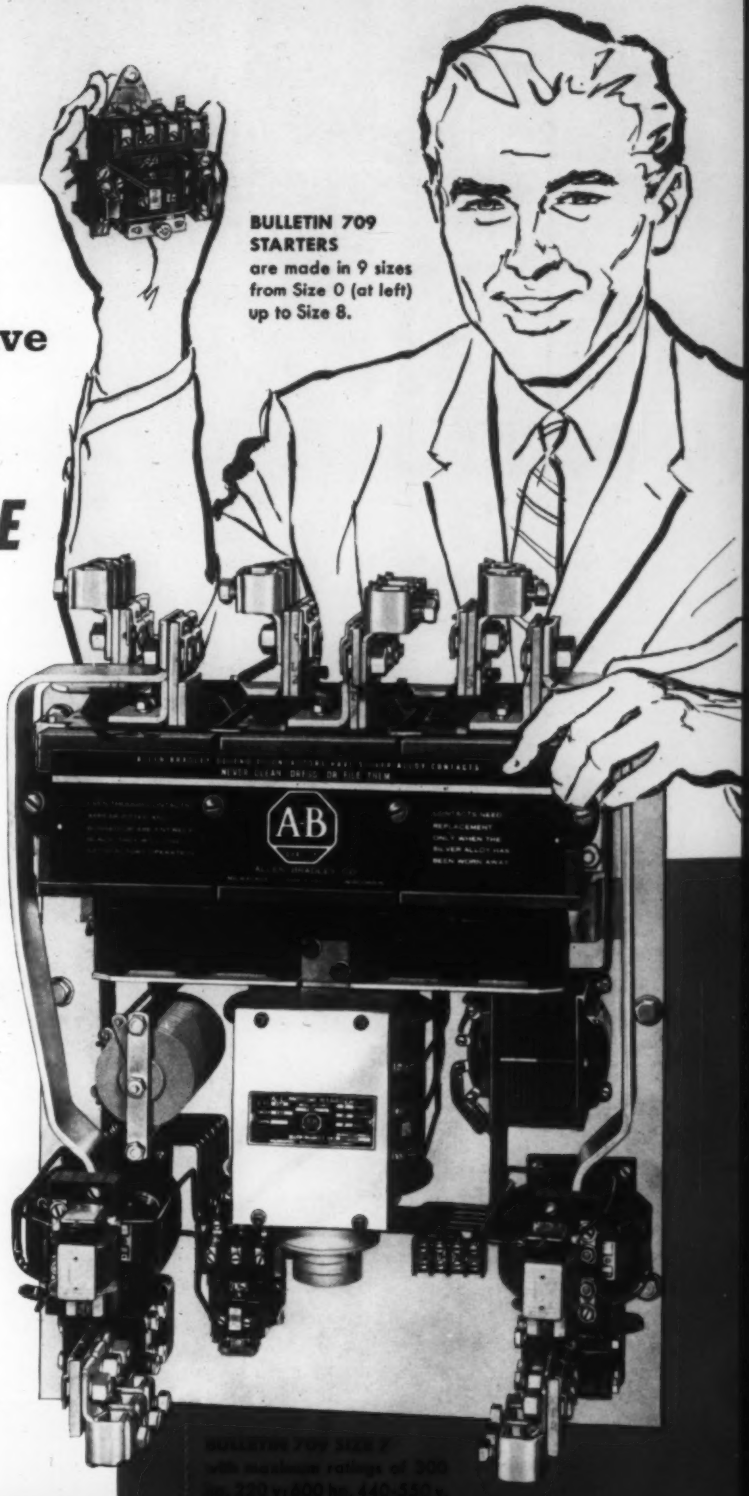
Wide range of sizes is offered in line of selenium rectifiers. Illustrated Catalog 51195 offers data on cell sizes from 1 in. square to 12 x 16 in. and for stacks of practically any size. 10 pages. Syntron Co., 260 Lexington Ave., Homer City, Pa. F

Circle 893 on Page 19

Circle 559 on Page 19→

A-B
QUALITY

ALLEN-BRADLEY
Solenoid Starters give
MORE MILLIONS OF TROUBLE FREE OPERATIONS



BULLETIN 709 STARTERS
are made in 9 sizes
from Size 0 (at left)
up to Size 8.

BULLETIN 709 SIZE 7
with maximum ratings of 300
hp, 220 v; 600 hp, 440-550 v.

. . . and for good reasons

- **ONE MOVING PART**
  With this simple solenoid design, there's virtually nothing to go wrong—all trouble-causing bearings, pivots, and flexible jumpers have been eliminated.

- **DOUBLE BREAK, SILVER ALLOY CONTACTS**
  Allen-Bradley silver alloy contacts never require maintenance. They are always in perfect operating condition . . . and remain so until completely worn away.

- **SIMPLE UP-AND-DOWN MOTION**
  The virtually frictionless, straight line vertical motion provides uniform contact pressure at all times—and assures consistent, rapid operation of the contactor.

- **RELIABLE OVERLOAD PROTECTION**
  All A-B starters are equipped with two permanently accurate and reliable overload relays that protect motors against "burnouts." Three overload relays can be furnished.

ALLEN-BRADLEY
MEMBER OF NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

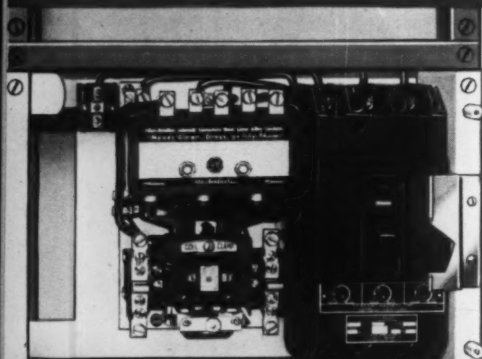
QUALITY
MOTOR
CONTROL

Advanced Design Features in a Control Center . . .

ALLEN-BRADLEY

CONTROL CENTERS

. . . offer tops in
FLEXIBILITY • SAFETY
QUALITY APPEARANCE



This typical unit of an A-B control center shows a Bulletin 709, Size 2 starter and an I.T.E. circuit breaker.

Allen-Bradley control centers are the "label" of a modern plant. They make neat, centralized installations and—where this is practical—do away with individual starter mountings and complicated wiring. The control center may even reduce installation cost—as compared with using individual starters. Here are some of the up-to-date design features which make the A-B control centers so popular.

NEW SPACE SAVING DESIGN—New Bulletin 798 control centers save floor space . . . provide up to 8 units in a 90" high control center unit.

PREMIUM QUALITY FINISH—An exclusive A-B finishing process assures that your control center will retain its attractive appearance over the years. Each piece is *individually* cleaned and phosphated *before* assembly—there are no "bare spots" where corrosion can have a start. Then a rust-resisting primer and a dense finish coat are baked on, providing a fine, tough, and lasting surface.

FLEXIBILITY—A-B control centers are readily adaptable to changes in operating needs—integral plug-in units can be added or modified without internal rewiring. Entire sections are easily added as needed.

SUPERIOR PERFORMANCE—Using the popular A-B solenoid starter—with only ONE moving part—assures millions of trouble free operations. Their double break, silver alloy contacts *never* need servicing.

For "tops" in control centers, you owe it to yourself to investigate Allen-Bradley's Bulletin 798. Write for complete information.

ALLEN-BRADLEY

MEMBER OF NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

6-59-MR

QUALITY
MOTOR
CONTROL

Chemical Milling

Recent advances in the art of chemically milling steel and "super" alloys in any stage of fabrication are related in Design Bulletin 8. Effects of heat treating, surface finishes, and physical properties are given. 2 pages. United States Chemical Milling Corp., 1700 Rosecrans Blvd., Manhattan Beach, Calif. L

Circle 894 on Page 19

Protective Coatings

Bulletin 100 deals with various types of Carboline corrosion resisting coatings. Recommended materials, application techniques, and suggested uses are tabulated. Condensed information is given on primers, maintenance coatings, floor coatings, and tank linings. 4 pages. Carboline Co., 32 Hanley Industrial Court, St. Louis 17, Mo. I

Circle 895 on Page 19

Indicator Light

Miniature No. 101-N-022 indicator light with built-in 22,000-ohm resistor makes use of the G-E NE51H neon lamp which is about 20 times brighter than the lamp it replaces. Light unit is described on data sheet. 1 page. Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill. I

Circle 896 on Page 19

Coordinate Drawing Machines

Dimensionally accurate drawings suitable for optical profile projectors and reproduction are made on Aristo Coordinatographs, a series of coordinate drawing machines. Specifications of available models and examples of work produced are included. 8 pages. Unitech Corp., 50 Colfax Ave., Clifton, N. J. D

Circle 897 on Page 19

Carbon Steel Balls

Wide range of products in which Sterling carbon steel balls are used is described in illustrated brochure. Accuracy and uniformity are stressed and details of 1/8 to 3/4-in. sizes available are given. 4 pages. Sterling Commercial Steel Ball Corp., Box 401, Sterling, Ill. J

Circle 898 on Page 19

Liquid Level & Flow Control

Controls for control of liquid level and liquid flow are subject of Bulletin ERS-A. Twenty-one case studies using this equipment are included, as are engineering information, schematic drawings, and electrical wiring diagrams. 20 pages. McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill. I

Circle 899 on Page 19

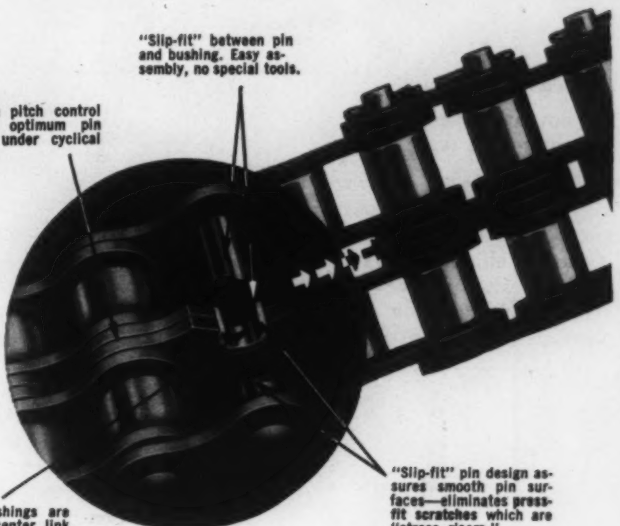
Soldering Aluminum

Latest information on soldering of aluminum is presented in illustrated Booklet 802. It covers soldering fluxes, irons, and flames and explains hot plate, dip, furnace, friction, glass fiber brush, and ultrasonic soldering methods. Types and properties of aluminum solders are described. 22 pages. Request upon company letterhead from Reynolds Metals Co., Dept. PRD-6, Box 2346, Richmond 18, Va. C

Are you getting all the "extra" values for your chain drive dollar?

FOR EXAMPLE:

"BUSHED CENTER LINK DESIGN"...



"Slip-fit" between pin and bushing. Easy assembly, no special tools.

Precision pitch control provides optimum pin support under cyclical loading.

Hardened bushings are press-fit in center link plates . . . pre-stresses critical areas for greater fatigue life.

"Slip-fit" pin design assures smooth pin surfaces—eliminates press-fit scratches which are "stress risers."

Whitney **bushed center link** design can provide **at no additional cost,** up to a **25% increase in endurance limits,** as compared to other standard chains. This means substantial cost savings on higher horsepower, multiple strand chain drives — assures maximum service life and minimum maintenance.

The "bushed center link" features shown above results in the pre-stressing of link plates for greater fatigue life, **plus** the added advantage of easy assembly or disassembly without special tools. This design feature is carried throughout the Whitney Chain and is **not** limited to connecting or offset links.

AND STILL MORE "ENGINEERED EXTRAS"...
"Line" blanked plates — Whitney Chain plates are blanked **parallel** to the rolling direction of the plate stock. This provides higher fatigue resistance since the areas of highest stress cannot be coincident with possible grain discontinuities.

SHOTPEENED PARTS—Whitney Chain parts are shotpeened over a wide range of sizes. This treatment introduces residual stresses which increase the fatigue life of the parts.

PRE-STRESSED PLATES—Unique compressive technique applied to **heat treated** alloy steel chain links builds in concentrated residual stresses in the pitch hole area for greater dynamic strength.

SOLID ROLLS—Whitney rolls, 1" pitch and up, are turned from special alloy bar stock —**not** formed from strip. These solid rolls stand up under punishing extremes . . . take higher impact loads over many additional hours of service.

Ask your Whitney Field Engineer how these Whitney standards can be applied to your power transmission or conveying problem for the utmost in service and dependability.

Write today for helpful, practical Whitney catalogs.

Whitney
CHAIN COMPANY
A SUBSIDIARY OF FOOTE BROS. GEAR AND MACHINE CORPORATION
412-C HAMILTON STREET • HARTFORD 2, CONN.

ROLLER CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS • WHITNEY-TORMAG DRIVES

Circle 560 on Page 19

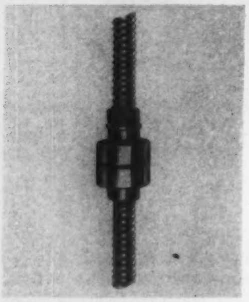
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Antifriction Bearing

is now available in positive-drive type

Antifriction nut and screw assembly accomplishes conversion of rotary to linear force and motion with high operating efficiency. It is now available with positive-drive linear actuation in addition to original planetary-drive style. Positive-drive style has threads on one end of cage element for load or power source attachment. Positive linear advancement is equal to the lead, and unit is adaptable to multiple-screw applications requiring synchronized advancements. **Roton Products Div., Anderson Co.,** 1075 Grant St., Gary 40, Ind. J



Circle 900 on Page 19

Subminiature DC Motors

are of permanent-magnet design

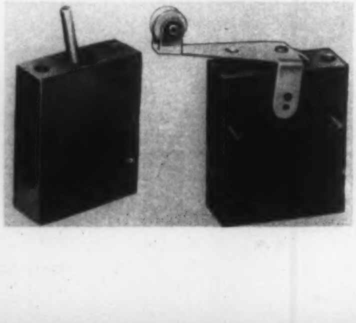
Subminiature motors are available for operation on any specified dc voltage between 3 and 30 v, with armatures wound to produce any desired no-load motor speed between 5000 and 20,000 rpm as specified input voltage. Type 810 motors are of permanent-magnet design, combining high torque output at high speeds in a small, lightweight unit. Locked-rotor (maximum) output torque for motor without gear train is about 0.7 oz-in. between output speeds of 5000 and 15,000 rpm. Internal gear trains are available for higher torque at reduced output speeds. With internal speed governor, speed regulation is within ±2 per cent for ±20 per cent voltage variable from no load to rated load. **Cramer Controls Corp.,** Centerbrook, Conn. B

Circle 901 on Page 19

Miniature Valves

for operating temperatures of −40 to +200 F

Micro Valves are miniature units with overcenter, snap-action operator. Basic valve is a three-way, two-position unit which can be adapted easily for two-way shut-off service. Units provide instantaneous response with no neutral position and no varying time lag between positions. Valves will handle abrasive-bearing fluids. Many sizes and types are available in many materials, with variety of operators and accessories. Working pressures of 0-100 psi can be applied at any port. Operating-temperature range is −40 to +200 F in 1/16 and $\frac{1}{8}$-in. orifice. Valves with orifice of $\frac{1}{4}$ in. are also available. **Instruments Inc.,** Box 556, Tulsa, Okla. P



Circle 902 on Page 19

Polyurethane Foam

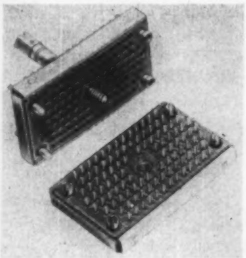
has permanent, pressure-sensitive adhesive

Self-adhesive foam incorporates properties of polyurethane foam with permanent pressure-sensitive adhesive. Applications include cushioning, insulating, soundproofing, and weather stripping. Foam can be die cut, guillotined, or slit on conventional equipment. It is available in thicknesses from $\frac{1}{8}$ to 1 in. in rolls, or in sheets up to 52 in. wide. **Fasson Products, Div., Avery Adhesive Products Inc.,** 250 Chester St., Painesville, Ohio. G

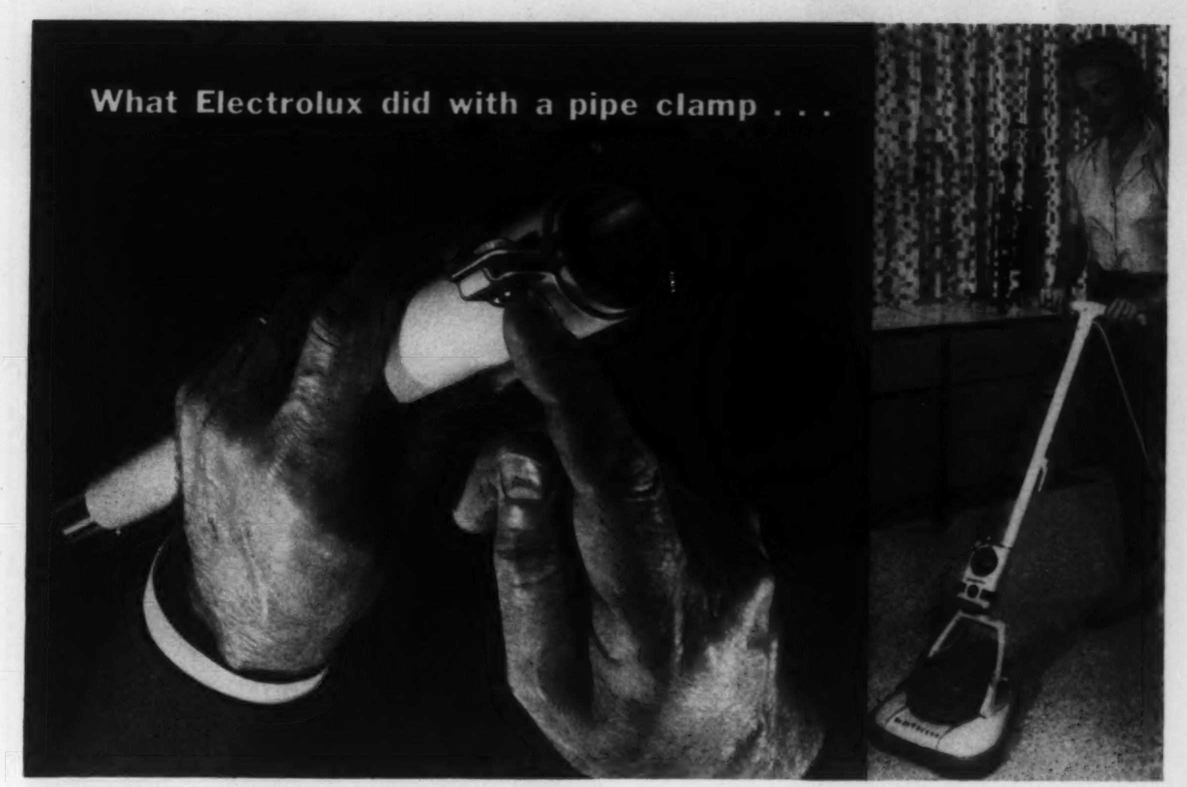
Circle 903 on Page 19

Miniature Connectors

rectangular units are for heavy-duty applications



Miniature rectangular connectors incorporate center screwlock and closed entry contacts. The pin-and-socket units, designated Series 1900, are for heavy-duty applications in aircraft and electronic equipment. They have high dielectric and mechanical strength, and feature stainless-steel channels riveted to long sides of plug and receptacle. Body material is molded from glass-filled diallyl phthalate. Choice of 104 or



you can do–if you know about Perma-Nuts

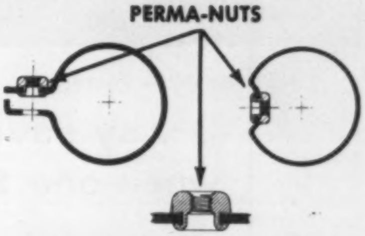
The common pipe clamp gained new glamor and new advantages when an Electrolux engineer added to it the unique values of a Perma-Nut.

For Electrolux, this new TRS internally-threaded tubular rivet meant a simpler, neater looking and cost-cutting assembly for their waxer handle . . . plus an appliance easier to pack, easier to ship, and easy for anyone to assemble.

For you too, Perma-Nuts can transform the lowly, low-cost pipe clamp into a more desirable device. You will eliminate separate, awkward to install and easily lost nuts and washers. You save the operations needed to hold nuts captive. You gain attractive appearance. A built-in lock washer under the head locks the Perma-Nut against turning. Perma-Nuts are fed and set by standard TRS riveting machines — with all the speed and sureness of rivets — and are available in a wide range of standard machine screw thread sizes.

Improvement of pipe clamps is only one of many uses for this versatile new fastener. Write for your free copy of the new Perma-Nut Catalog, and see how many ways Perma-Nuts simplify attachment problems, speed assembly, cut production costs.

Whatever your assembly problems, invite the TRS man to check them over. You'll find that he is more than a salesman . . . that he has the viewpoint of a manufacturing engineer. Chances are he can contribute practical ideas for making your assemblies simpler, faster, better.



TWO WAYS PERMA-NUTS HELPED

1. A Perma-Nut is set in the flange of the pipe clamp before forming into a circle, to make a neat, permanent and strong nut plate. Clamp holds handle to waxer.

2. To join the two sections of the handle, a Perma-Nut is set in a dimple in one end of the lower section, forming a nut plate over which the top section of the handle slides to be secured by a captive screw.

Don't Buy Riveting Machines until you learn how the TRS **PAR** *process revolutionizes riveting*

TRS

TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASSACHUSETTS • TRS SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago
Cleveland • Dallas • Detroit • Hartford • Indianapolis • Los Angeles • New York
Philadelphia • Pittsfield • Quincy • St. Louis • Seattle. WAREHOUSE IN CHICAGO
See "Yellow Pages" for phone numbers.

If it's a Tubular Rivet TRS makes it . . . and Better

Engineered by Tinnerman...

3-way savings for Chrysler Corporation when one **SPEED NUT**® replaced 5 parts

Four parts eliminated...

Parts cost reduced 40%...

Assembly costs cut 12%...

All these savings were accomplished when the Chrysler Corporation switched to a Tinnerman-engineered SPEED NUT Brand Fastener developed to hold car and truck window vents in place. The all-spring-steel fastener serves as a friction brake to hold the vent at any desired position.

You, too, can achieve savings like these on parts for your assemblies . . . a no-obligation Tinnerman SPEED NUT Fastening Analysis will quickly locate the places. Your Tinnerman sales representative will discuss your problem, arrange for the Analysis. He's listed in your Yellow Pages under "Fasteners." Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®
FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

Circle 562 on Page 19

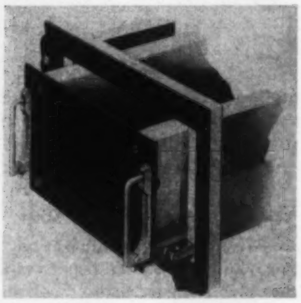
34 contacts is presently available. **Electronic Sales Div., DeJur-Amsco Corp.,** 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 904 on Page 19

Chassis Latch

has pushbutton release on locking device

Improved chassis latch, designated 35L, is for use in engaging, disengaging, and carrying equipment-filled drawers such as utilized in electronic racks. Latch has a pushbutton release mechanism on locking device which permits simplified, quick release of multiple-pin connectors used with plug-in chassis. When returned to locked position, latch becomes a carrying handle. Adequate mechanical advantage is provided to engage connector plugs with forces up to 400 lb, without deforming structures. Latch consists of only a handle and a fork assembly. **Camloc Fastener Corp.,** 37 Spring Valley Rd., Paramus, N. J. D

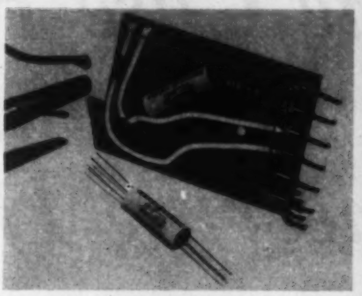


Circle 905 on Page 19

Subminiature Relay

has 1 millisec operating time

Less than 1 in. long and approximately $1/4$ in. in diam, Unimite single-pole, double-throw relay is available for general-purpose use. It has 1 millisec operating time and 3 millisec release time. Relay can be cycled at 10,000 operations per minute. Contact chamber, hermetically sealed and isolated from coil, contains only inorganic and chemically inert materials to virtually eliminate contamination of contacts. Contacts are rated 1 amp at 28 v dc, and meet overload requirement of MIL-R-5757C (4 amp) and MIL-R-25018 (2 amp). Required operating power is approximately 240 mw. Minute size and low power requirements permit use in multiples when a variety or diversity of contact arrangements is desired. Relay has been shock tested to 40 g and vibration tested to 30 g from 55 to 2000 cps. **General Electric Co.,** Schenectady 5, N. Y. C



Circle 906 on Page 19

Rubber-to-Rubber Adhesive

heat bonds dissimilar unvulcanized elastomers

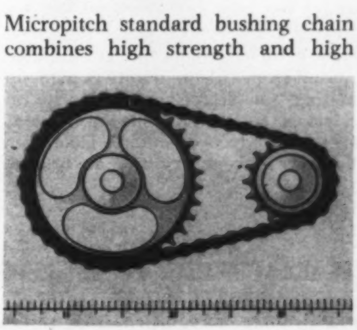
EX-B-50-1 adhesive bonds two dissimilar, unvulcanized elastomers for applications such as conveyor belt covers to bodies, wire and cable jackets to insulation, hose covers, and roll covers. Adhesive produces rubber-tearing bonds which resist aging and retain high strength after prolonged flexing. It can be used when one of the stocks involved is based upon butyl rubber, and in many cases produces good bonds even if one stock is cured. When used with a primer, it bonds rubber stocks to many other substrates such as plastics or metals. Dept. 88, **Special Products Div., Lord Mfg. Co.,** Erie, Pa. F

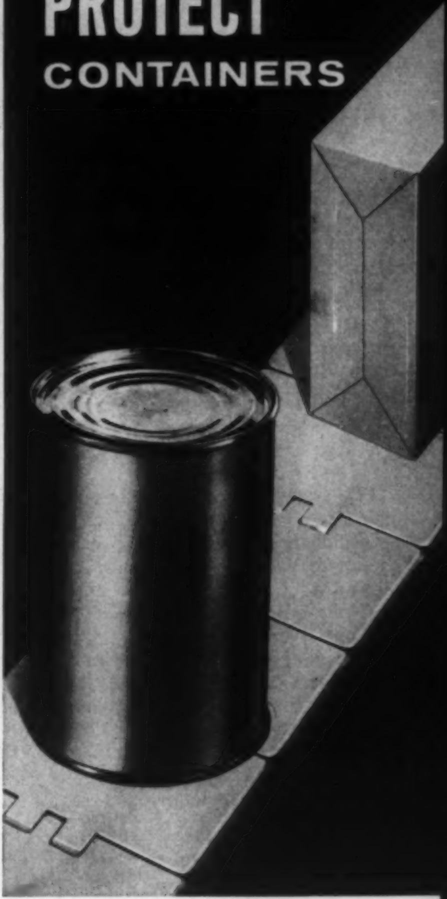
Circle 907 on Page 19

Bushing Chain

has pitch of 0.1475 in.

Micropitch standard bushing chain combines high strength and high





Another PLUS value...

IT'S NYLON TO

PROTECT

CONTAINERS

Rex Nylon TableTop Chain is easy on containers because *it operates without lubrication.* No lubricant stains to soil containers...no "wearing" metal-to-metal contact when handling cans!

Nylon TableTop is smooth in operation. It's quiet...easy to assemble...stays cleaner and is easy to clean. For complete information, mail the coupon.

REX®

NYLON TABLETOP®

CHAIN Belt Company
4643 W. Greenfield Ave.
Milwaukee 1, Wisconsin

108-A

(In Canada: CHAIN Belt Canada Ltd.,
1181 Sheppard Ave. East, Toronto)

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Company..................................

Address..................................

City..................*Zone*.....*State*......

Circle 563 on Page 19

The Case For 105mm Miniaturization of Engineering Drawings

Micro-Master® 105mm, supplied by K&E, is the only system designed specifically for engineering drawings

Micro-Master 105mm offers the general advantages you expect of any miniaturization system – space savings, protection of costly originals, and ready distribution of duplicates. But Micro-Master provides these advantages *without* over-mechanization. A 105mm negative – measuring a generous 4 by 6 inches – is large enough to be located easily and read quickly without elaborate scanning and sorting devices. In addition, a national network of K&E dealers stands ready to provide the 105mm service you need.

A Complete System from Film to Print

Micro-Master is a totally integrated system for photographing, film processing and final reproduction or projection printing. Completely precision-engineered – from optics through films, papers and chemicals – the system provides extremely sharp, high-contrast "thin" negatives that furnish high-quality, absolutely uniform prints. Critical alignment of camera and projector, and special vacuum frames which hold materials absolutely flat, are typical of the optical and mechanical features that make the Micro-Master system an engineering aid of highest quality.

No Distortion in Blow-Backs

Maximum reduction or enlargement for Micro-Master 105mm is 10 diameters –not up to 30 diameters as with smaller negatives. Thus, when drawings as large as 40 by 60 inches are reduced or re-enlarged, they retain a clear, sharp quality – even in the corners. There is no distortion or loss of detail, for all Micro-Master reproductions are made inside the photographic "quality barrier" of 10 diameters. Projection prints can be made on inexpensive paper as well as on cloth or film.

Like-New Prints from Worn Originals

Old originals can be restored, too – even when badly damaged. The Micro-Master process uses *reflected* rather than transmitted light. Thus, detail which has been lost through light absorption – due to dirt or discoloration – will "snap back" on the film – giving you clean prints with clear backgrounds and sharp black lines equal to ink lines. The large negative size makes it easy to see and eliminate unwanted areas by "opaquing out." Any small paint brush can be used for this purpose.

Easy to Read . . . Always Accessible

You can read almost every detail on a 105mm negative just by holding it up to a window or other light source. Table viewers are recommended for close study, but are *not necessary* in the "search and selection" phase. In a large plant or office, engineers can find and consult from 105mm negatives without waiting for search and delivery of originals, and without having to blow back tiny reductions to a readable size. Engineers or technicians at branch plants, warehouses or field installations can maintain compact, complete files of project information – accessible at any time without special equipment.

Easy to File, Easy to Mail

Micro-Master is a miniaturization system providing *individual* negatives that meet archival requirements. Each negative is kept in its own 5″ by 8″ envelope. There is ample space on the envelope for large, legible identification coding and other information. Over 12,000 drawings can be stored in a standard 5″ by 8″ card file cabinet. No complicated cross-indexing is needed, for negatives of original drawings and all subsequent revisions can be grouped in the same file, ready for immediate reference. The absence of sorting devices eliminates scratches and other film damage resulting from excessive mechanical handling.

See Your K&E Dealer for Information, Equipment, Service

A camera, projector, three types of viewers, and all necessary printing accessories are available with the Micro-Master system, and all equipment can be obtained through your local K&E distributor. He can also furnish 105mm reductions and enlargements of your drawings as a service. For complete information, call your K&E dealer, or write to Keuffel & Esser Co., Dept. MD-5, 300 Adams St., Hoboken, N. J.

1634

K+E

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • DETROIT • CHICAGO • MILWAUKEE • ST. LOUIS • DALLAS • SAN FRANCISCO • LOS ANGELES • SEATTLE • MONTREAL

Circle 564 on Page 19

resistance to joint wear with minimum size and weight. It permits an infinite variety of shaft centers, and multiple shafts can be timed accurately because sprockets can engage both sides of chain. Applications include use in electromechanical equipment, communications devices, cameras, ordnance instrumentation equipment, instruments, radar, data-processing machines, and tape recorders. ASA No. 25—1/4 in. pitch chain is available from stock in stainless or standard steel. Width of chain is 0.21 in., weight is about 1/2 oz per ft, and pitch is 0.1475 in. **Diamond Chain Co. Inc.**, 402 Kentucky Ave., Indianapolis 7, Ind. J

Circle 908 on Page 19

Miniature Air Cylinder

in 3/8 and 9/16-in. bore sizes

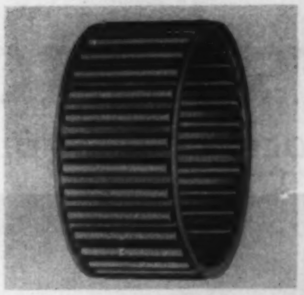
Spring-return miniature air cylinder, designated Minimatic, is a hollow-shaft unit. Cylinder is available from stock with stud mountings only, but can also be clamp-block-mounted easily. It is furnished in 3/8 and 9/16-in. bore sizes in numerous stroke lengths. **Clippard Instrument Laboratory Inc.**, 7390-N Colerain Rd., Cincinnati 39, Ohio. G

Circle 909 on Page 19

Roller-Cage Assemblies

in 18 sizes from 1/2 in.

Needle cage and roller assemblies meet space restrictions in applications such as idler gears, planetary gears, seaming rolls, or locations where shaft and housing surfaces can be hardened and ground. Assemblies utilize 1/8-in. diam precision-ground rollers, permanently aligned in pockets or bronze cages centered on housing surface. Cage-guided rollers will not skew or misalign. Units are available in 18 sizes from 1/2 to 2-in. shaft diam, in choice of two lengths for each shaft diameter. **Orange Roller Bearing Co. Inc.**, 557 Main St., Orange, N. J. D



Circle 910 on Page 19

Name Plates and Labels

have Mylar coating on outer surface

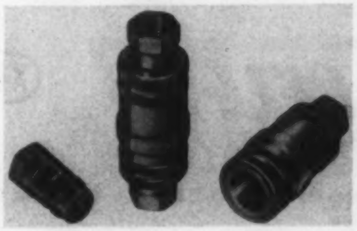
Adhesive-backed, flexible name plates and labels, designated Foil-cals, are fabricated on 0.003-in. aluminum, 0.003-in. brass, 0.002-in. stainless steel, or vinyl plastic, with sunken or raised etched letters. One-mil coating of Mylar is applied to outer surface to lock in both color and lettering and to provide high abrasion and chemical resistance. Mylar name plates are available in a wide range of materials and colors. Radium, phosphorescent, and fluorescent lettering are available. **Miller Dial & Name Plate Co.**, 4400 N. Temple City Blvd., El Monte, Calif. L

Circle 911 on Page 19

Quick-Disconnect Coupler

for temperature range of −40 to +250 F

Use of quick-disconnect coupler SP-500 permits connection or disconnection of hydraulic lines at full



Another PLUS value...

PREMIUM CHAIN
...NO EXTRA COST

Rex Roller Chains are designed to give you longest possible wear life. For example, as shown above, all standard roller chains have oil holes in the bushings to assure easy penetration of life-adding lubricant to the important pin-bushing contact area...a vital factor, particularly on high-speed drives. You get many more cycles of wear life...a PLUS VALUE premium chain at no extra cost. For complete information, mail the coupon.

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ROLLER CHAINS

CHAIN Belt Company 414
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Milwaukee 1, Wis.
(In Canada: CHAIN Belt Canada Ltd., 1181 Sheppard Ave. East, Toronto, Ontario.)

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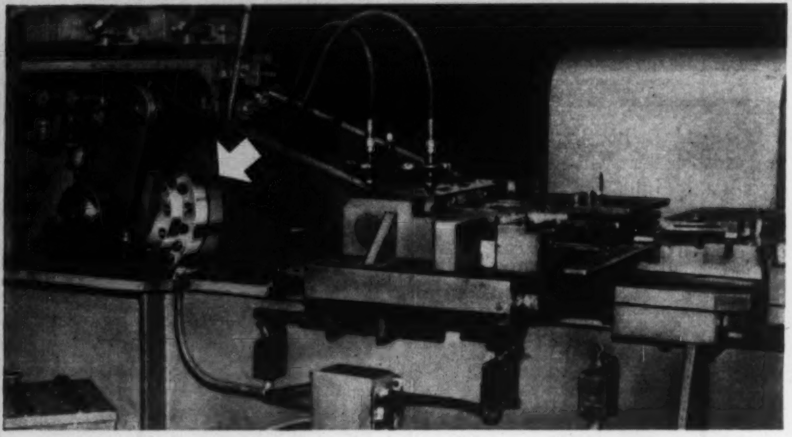
City..................Zone....State......

Circle 565 on Page 19

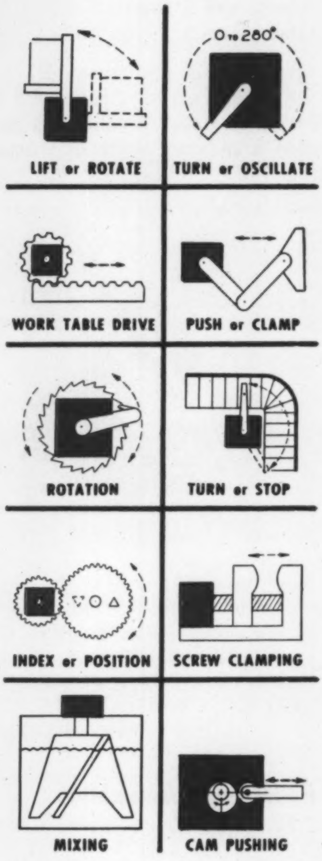
RŌTAC®

EXERTS 60-TON FORCE

. . . In 1/6th the Space of a Straight-line Actuator!

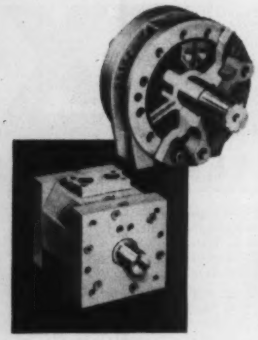


***Left:* Every 1½ minutes, a Model HN Rōtac Torque Actuator on this wire-forming machine exerts a 60-ton force on the work through a simple toggle arrangement. Higher torque and higher speed—in a fraction of the space required by a straight-line power unit, control valves and motor—add up to Rōtac efficiency! (Photo courtesy Stubnitz Greene Corp.) *Below:* These typical Rōtac applications might suggest the answer to your design problem:**



Rōtac Reciprocating Rotary Torque Actuators are designed to do more jobs that cannot be done easily or economically with other devices. **Torque** is instantaneous and uniform through the required arc. **Ratings** range from 100 to 40,000 inch-pounds for standard single-vane models, from 240 to more than 200,000 inch-pounds in double-vane models. **Power source** can be air, oil or other fluids, with operating pressures to 1,000 psi in standard Rōtac units. **Mounting** can be vertical, horizontal or at any angle, and RN models can be safely manifold mounted. **Rotation or oscillation** (to 280° in single-vane models) can be stopped, started, slowed down or speeded up. **Application** is unlimited; among hundreds of uses are mobile installations, machine tool and various light and heavy industrial applications. **Construction** conforms to J.I.C. standards, and to Ex-Cell-O's own high requirements for precision, long life and low maintenance. **Special designs** available for unusual applications, military and aircraft use. **Delivery** of a wide range of standard catalog models is fast. See your local Rōtac Representative or write direct.

59-R-2



FREE DESIGN DATA BOOK—20 PAGES

Contains everything you'll want to know about RŌTAC—How it works • Control • Typical applications and special uses • Installation details • Dimensions • Torque ratings.

EX-CELL-O CORPORATION

Greenville Plant, 945 E. Sater St., Greenville, Ohio

XLO ***EX-CELL-O FOR PRECISION***

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • THREAD AND GROOVE GAGES • GRANITE SURFACE PLATES • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

Circle 566 on Page 19

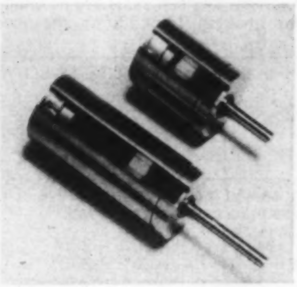
operating pressure without sacrificing automatic breakaway characteristics. Unit handles a broad range of fluid media and has operating temperature range −40 to +250 F. Operating pressures exceed 7500 psi. Coupler has full swivel action, absorbs torsional strains and stresses from adjacent components, and eliminates need for swivel adaptors. **Bruning Co.,** 601 S. Ninth St., Lincoln, Neb. I

Circle 912 on Page 19

Mechanical Limit Stop

adjustable unit has torque capacity of 60 oz-in.

Infinitely adjustable mechanical limit stop is available in two sizes having 10.5 and 42 turns maximum. Starting torque is 0.1 oz-in. maximum, and torque capacity is 60 oz-in. Housing diameter is 0.937 in., and shaft diameter, 0.1873 in. Housing lengths are 1¼ and 2½ in. with respective shaft lengths of ¾ and 1 in. **Gap Instrument Corp.,** 116 E. Merrick Rd., Freeport, L. I., N. Y. D

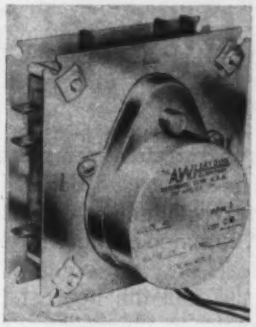


Circle 913 on Page 19

Electrical Programmers

for high-volume commercial and industrial applications

Series 41900 electrical programmers offer versatility in solving complex electrical switching problems in high-volume industrial and commercial applications. Applications include vending machines, appliances, automation controls, industrial programming, advertising displays, and others where predetermined electrical switching must be accomplished. Programmers can be adapted readily to a variety of special requirements. Design features include: Use of from one to eight single-pole, double-throw, snap-action switches; option on mounting with four studs and four corner notches supplied; wide range of cycling times from 30 sec to 24 hr per cycle; power input only 2 w to motor at 115 v, 60 cps; use of quick-connect terminals to facilitate rapid installation. **A. W. Haydon Co.,** 232 N. Elm St., Waterbury 20, Conn. B



Circle 914 on Page 19

Teflon Rod

nonextruded lengths have high tensile strengths

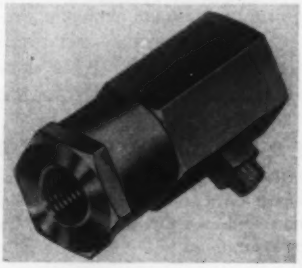
Nonextruded pure and filled-Teflon rod in 30-in. lengths is available from stock in ⅛, ¼, ⅜, and ½-in. diam. Tensile strength and elongation are superior to those of extruded Teflon rod. High density and uniformity without chipping are also features of the rod. Teflon-filled rod has minimum tensile strength of 2000 psi and elongation of 200 per cent. Additional diameters to 1 in. will also be available soon. **Modern Industrial Plastics Inc.,** 3337 N. Dixie Drive, Dayton 14, Ohio. G

Circle 915 on Page 19

Speed-Control Valve

handles 0-150 psig air service

Low-cost, lightweight speed-control valve, designated Cub, is available in ⅛ and ¼-in. pipe sizes. It



Another PLUS value...

CUSHIONS
IMPACT
LOADS

The roller in a roller chain must provide maximum resistance to its impact against sprocket teeth for longest wear life. A *PLUS VALUE* of Rex Roller Chains is really round rollers. This provides full bearing against the bushing for maximum life. For complete story, mail the coupon.

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ROLLER CHAINS

CHAIN Belt Company 403
4643 W. Greenfield Ave., Milwaukee 1, Wis.
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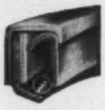
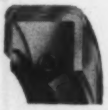
Circle 567 on Page 19

NATIONAL OIL SEAL LOGBOOK

Oil Seal Selector Chart

The data given below indicate, for most common applications, the type of oil seal that will operate best under given conditions. Where one or more parameters are extreme, modified or special seals may be required. For engineering help or availability details, call the nearest National Seal Engineer. Look under Oil Seals, in the Yellow Pages.


50,000 series
Micro-Torc
Leather


450,000 series
Syntech
Synthetic

410,000 series
Syntech
Synthetic

		50,000 series Micro-Torc Leather	450,000 series Syntech Synthetic	410,000 series Syntech Synthetic
MATERIAL SEALED	Mineral base oils and greases are most common materials. Availability of lubricant, criticalness of service, and cleanliness strongly influence construction choice. National Micro-Torc leather seals are recommended for grease and oil applications and particularly where semi-starved lubricant conditions may exist. For oil and fluid "zero leakage" service Syntech seals are normally considered. For applications involving both "zero leakage" and heavy dirt conditions, the user may wish to consider dual lip Syntech seals.			
SHAFT SPEED	Prime factor in seal selection. Governs all other factors. Shown in FEET PER MINUTE AS SLOW, MODERATE, HIGH.			
FPM	Slow	0 to 800	0 to 1000	0 to 1000
	Moderate	800 to 1500	1000 to 2000	1000 to 2000
	High	1500 to 2000	2000 to 3000	2000 to 3000
TEMPERATURE	Limits shown are points where sealing material or medium sealed becomes ineffective. For sealing under extreme temperature conditions, special compounds can be employed.			
LIMITS °F.	Continuous	−65° +200°	−65° +225°	−65° +225°
	Intermittent	−65° +225°	−60° +250°	−60° +250°
PRESSURE	Conventional oil seals are not pressure seals. Where pressures above those shown exist, special seals should be employed or pressure against sealing lip relieved.			
MAXIMUM PSI	Slow	15	10	10
	Moderate	10	7	7
	High	5	5	5
SHAFT FINISH	Fineness and type of finish, direction and spiral of finishing marks and leads as well as RMS value affect sealing. Polished or ground finishes with concentric finish marks are preferred.			
MAXIMUM MICRO INCHES	Slow	25	25	25
	Moderate	20	20	20
	High	20	20	20
SHAFT HARDNESS	Although shafts as soft as cold rolled steel can be sealed successfully, hardness of C20 Rockwell or greater is preferred. Fluid starvation, abrasives and high surface speeds require hard shafts.			
SUGGESTED ROCKWELL	Abrasives	above C-45	above C-45	above C-45
	No abrasives	above B-80	above B-80	above B-80
SHAFT TO BORE MISALIGNMENT	Fixed misalignment of center of shaft rotation with bore center. Concentrates wear at one side of seal. Becomes more severe as speed increases.			
TOTAL INDICATOR	Slow	.010	.015	.015
	Moderate	.005	.010	.010
	High	.005	.010	.010
SHAFT RUN-OUT	Oscillating non-concentricity between shaft and bore centers (also eccentricity or shaft whip). Run-out should be kept to absolute minimum; creates difficult sealing problem.			
TOTAL INDICATOR RPM	0-800	.010	.025	.025
	800-2200	.005	.020	.020
	2200-4200	.003	.015	.015

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Redwood City and Downey, California
Van Wert, Ohio

NATIONAL
OIL SEAL

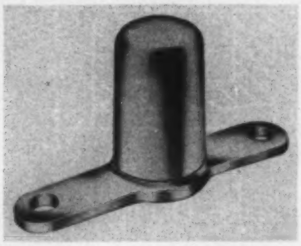
5206

offers metering adjustment which permits five full turns from closed to full open position. Short installation radius and small envelope dimensions make unit suitable for limited-space installations. It handles 0-150 psig air service. **Ross Operating Valve Co.**, 120 E. Golden Gate, Detroit 3, Mich. H

Circle 916 on Page 19

Anchor Nut

lightweight unit is for pressure-sealed areas



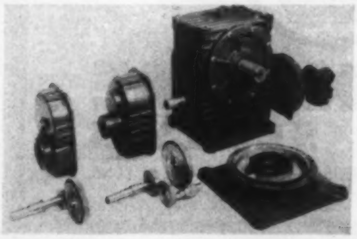
Two-lug dome anchor nut, No. 14600H, is a lightweight unit made of alloy for added durability. It is available in No. 10-32 and 1/4-28 thread sizes. Nut is used to hold tanks, and in pressure-sealed areas. **Nutt-Shel Co.**, 2701 S. Harbor Blvd., Santa Ana, Calif. L

Circle 917 on Page 19

Speed Reducers

are heavy-duty, wormgear types

High-capacity, heavy-duty wormgear speed reducers are available from stock in all ratios from 5 1/6:1 to 1212:1 with center distances from 3 to 21 in. and any horizontal or vertical drive arrangement. Helical attachments for double and triple-reduction units combine efficiency of helical gearing with high ratio advantage of worm gearing. Improved tooth forms, precision-ground alloy-steel worms, high-strength bronze gears, and precision-ground helical gearing provide space savings to 50 per cent. One basic housing design for each size makes mounting and drive arrangements more flexible than in previous units. Units can be supplied with a torque-control attachment to protect driving and driven equipment from damage due to overload. **Philadelphia Gear Corp.**, Erie Avenue & G Street, Philadelphia 34, Pa. E

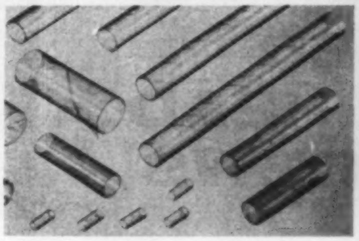


Circle 918 on Page 19

Mylar Coil Forms

thin-wall units will not separate at 400 F

Mylar thin-wall coil forms feature spiral windings cemented by a new method. Coils will not separate, even when Mylar itself shrinks on exposure to temperatures of 400 F. Tubes are especially suitable for shrinking onto coils, heavy wires, bus bars, and capacitor cans. Coil forms are available in any ID, OD, or length. Wall thicknesses range from 0.002 to 0.006 in. Tubes are highly resistant to moisture, solvents, and chemicals, and have high dielectric strength. They also possess excellent thermal characteristics and great tensile strength. Tubes neither dry nor become brittle with age. **Precision Paper Tube Co.**, Dept MD-1, 2035 W. Charleston St., Chicago 44, Ill. I

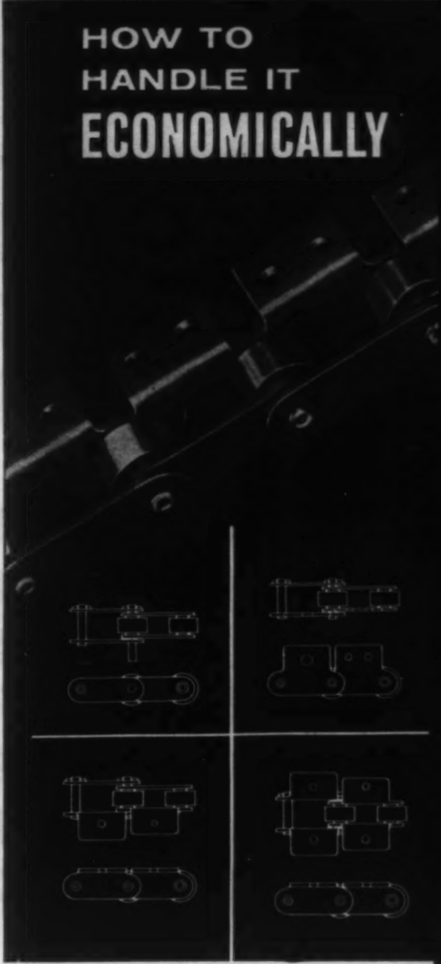


Circle 919 on Page 19

Fractional-Horsepower Motor

operates at 3600, 5000, 7500, or 10,000 rpm

Large brushes designed to provide performance beyond normal requirements, superprecision ball bearings, and sealed-in lifetime lubrication are available in classic fractional-horsepower motor. Speed governor and standard mounting plate are available. Unit is available in eight standard models operating at 3600, 5000, 7500, or



Another PLUS value...

HOW TO HANDLE IT ECONOMICALLY

Have you checked the advantages of Rex Roller Chains and Attachments for economical, smooth, efficient conveying? In the broad Rex line of standard and made-to-order attachments, there is probably a type that can do your conveying more efficiently. Your Rex Conveying Specialist will be happy to work with you...analyze your problem and recommend the type you need for better performance. Why not get in touch with him or mail the coupon for more data.

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ROLLER CHAINS

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Milwaukee 1, Wis.
(In Canada: CHAIN Belt Canada Ltd.,
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Circle 569 on Page 19

NATIONAL OIL SEAL® LOGBOOK

Oil Seal Selector Chart

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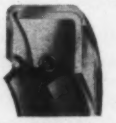
50,000 series
Micro-Torc
Leather

450,000 series
Syntech
Synthetic


410,000 series
Syntech
Synthetic

MATERIAL SEALED	Mineral base oils and greases are most common materials. Availability of lubricant, criticalness of service, and cleanliness strongly influence construction choice. National Micro-Torc leather seals are recommended for grease and oil applications and particularly where semi-starved lubricant conditions may exist. For oil and fluid "zero leakage" service Syntech seals are normally considered. For applications involving both "zero leakage" and heavy dirt conditions, the user may wish to consider dual lip Syntech seals.			
SHAFT SPEED	Prime factor in seal selection. Governs all other factors. Shown in FEET PER MINUTE AS SLOW, MODERATE, HIGH.			
FPM	Slow	0 to 800	0 to 1000	0 to 1000
	Moderate	800 to 1500	1000 to 2000	1000 to 2000
	High	1500 to 2000	2000 to 3000	2000 to 3000
TEMPERATURE	Limits shown are points where sealing material or medium sealed becomes ineffective. For sealing under extreme temperature conditions, special compounds can be employed.			
LIMITS °F.	Continuous	−65° +200°	−65° +225°	−65° +225°
	Intermittent	−65° +225°	−60° +250°	−60° +250°
PRESSURE	Conventional oil seals are not pressure seals. Where pressures above those shown exist, special seals should be employed or pressure against sealing lip relieved.			
MAXIMUM PSI	Slow	15	10	10
	Moderate	10	7	7
	High	5	5	5
SHAFT FINISH	Fineness and type of finish, direction and spiral of finishing marks and leads as well as RMS value affect sealing. Polished or ground finishes with concentric finish marks are preferred.			
MAXIMUM MICRO INCHES	Slow	25	25	25
	Moderate	20	20	20
	High	20	20	20
SHAFT HARDNESS	Although shafts as soft as cold rolled steel can be sealed successfully, hardness of C20 Rockwell or greater is preferred. Fluid starvation, abrasives and high surface speeds require hard shafts.			
SUGGESTED ROCKWELL	Abrasives	above C-45	above C-45	above C-45
	No abrasives	above B-80	above B-80	above B-80
SHAFT TO BORE MISALIGNMENT	Fixed misalignment of center of shaft rotation with bore center. Concentrates wear at one side of seal. Becomes more severe as speed increases.			
TOTAL INDICATOR	Slow	.010	.015	.015
	Moderate	.005	.010	.010
	High	.005	.010	.010
SHAFT RUN-OUT	Oscillating non-concentricity between shaft and bore centers (also eccentricity or shaft whip). Run-out should be kept to absolute minimum; creates difficult sealing problem.			
TOTAL INDICATOR RPM	0-800	.010	.025	.025
	800-2200	.005	.020	.020
	2200-4200	.003	.015	.015

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Redwood City and Downey, California
Van Wert, Ohio

NATIONAL
OIL SEAL

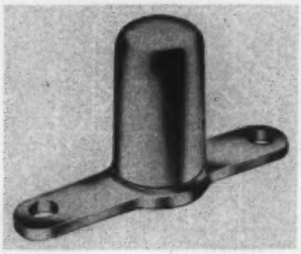
5206

offers metering adjustment which permits five full turns from closed to full open position. Short installation radius and small envelope dimensions make unit suitable for limited-space installations. It handles 0-150 psig air service. **Ross Operating Valve Co.,** 120 E. Golden Gate, Detroit 3, Mich. H

Circle 916 on Page 19

Anchor Nut

lightweight unit is for pressure-sealed areas



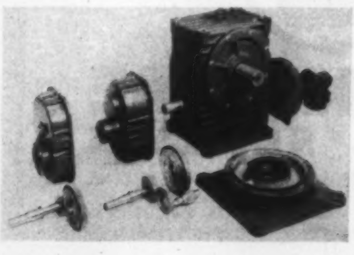
Two-lug dome anchor nut, No. 14600H, is a lightweight unit made of alloy for added durability. It is available in No. 10-32 and 1/4-28 thread sizes. Nut is used to hold tanks, and in pressure-sealed areas. **Nutt-Shel Co.,** 2701 S. Harbor Blvd., Santa Ana, Calif. L

Circle 917 on Page 19

Speed Reducers

are heavy-duty, wormgear types

High-capacity, heavy-duty wormgear speed reducers are available from stock in all ratios from 5 1/6:1 to 1212:1 with center distances from 3 to 21 in. and any horizontal or vertical drive arrangement. Helical attachments for double and triple-reduction units combine efficiency of helical gearing with high ratio advantage of worm gearing. Improved tooth forms, precision-ground alloy-steel worms, high-strength bronze gears, and precision-ground helical gearing provide space savings to 50 per cent. One basic housing design for each size makes mounting and drive arrangements more flexible than in previous units. Units can be supplied with a torque-control attachment to protect driving and driven equipment from damage due to overload. **Philadelphia Gear Corp.,** Erie Avenue & G Street, Philadelphia 34, Pa. E

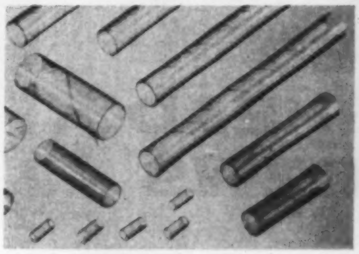


Circle 918 on Page 19

Mylar Coil Forms

thin-wall units will not separate at 400 F

Mylar thin-wall coil forms feature spiral windings cemented by a new method. Coils will not separate, even when Mylar itself shrinks on exposure to temperatures of 400 F. Tubes are especially suitable for shrinking onto coils, heavy wires, bus bars, and capacitor cans. Coil forms are available in any ID, OD, or length. Wall thicknesses range from 0.002 to 0.006 in. Tubes are highly resistant to moisture, solvents, and chemicals, and have high dielectric strength. They also possess excellent thermal characteristics and great tensile strength. Tubes neither dry nor become brittle with age. **Precision Paper Tube Co.,** Dept MD-1, 2035 W. Charleston St., Chicago 44, Ill. I

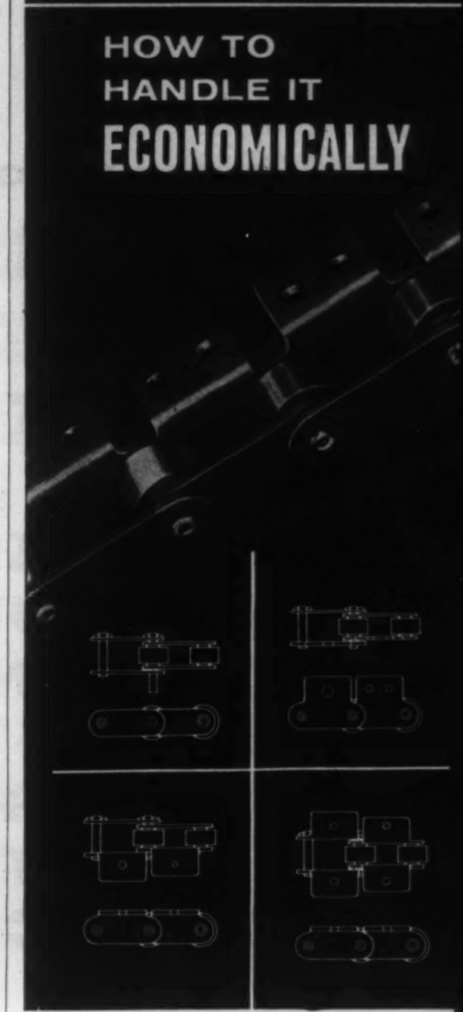


Circle 919 on Page 19

Fractional-Horsepower Motor

operates at 3600, 5000, 7500, or 10,000 rpm

Large brushes designed to provide performance beyond normal requirements, superprecision ball bearings, and sealed-in lifetime lubrication are available in classic fractional-horsepower motor. Speed governor and standard mounting plate are available. Unit is available in eight standard models operating at 3600, 5000, 7500, or



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Have you checked the advantages of Rex Roller Chains and Attachments for economical, smooth, efficient conveying? In the broad Rex line of standard and made-to-order attachments, there is probably a type that can do your conveying more efficiently. Your Rex Conveying Specialist will be happy to work with you...analyze your problem and recommend the type you need for better performance. Why not get in touch with him or mail the coupon for more data.

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Milwaukee 1, Wis.
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Name..............................
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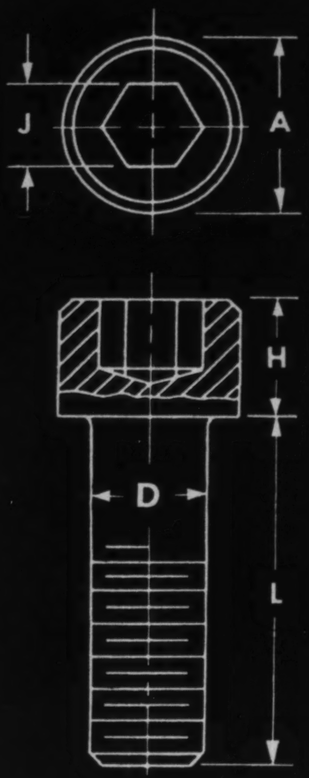
Circle 569 on Page 19

DESIGN ENGINEERS:

NEW ENGINEERING STANDARDS

MAKE SOCKET CAP SCREWS

AN EVEN BETTER FASTENER



HOLO-KROME ANNOUNCES THE NEW "1960 SERIES" FORGED SOCKET HEAD CAP SCREWS

Design engineers can now take a *fresh* approach to today's fastening problems as a result of new, *engineered* socket cap screw standards recently developed by engineers of the socket screw industry.

Two major advantages of the change—

INCREASED BEARING SURFACE

Head diameters were increased in certain sizes—5/16″, 7/16″, 5/8″, 3/4″, 7/8″, 1″—and the bearing surface under the head is larger. Designers can now take this increased bearing surface into account and obtain even better fastening from H-K Socket Screws.

LARGER SOCKETS, HIGHER TORQUE

Larger sockets in certain sizes—carefully selected after extensive testing—permit cap screws to be torqued to the maximum and allow designers to take full advantage of the tensile strength of H-K Socket Cap Screws.

Start *right now* to incorporate these new socket cap screw standards in your current design project.

SOLD ONLY THROUGH AUTHORIZED DISTRIBUTORS

FREE BROCHURE LISTS NEW DIMENSIONS

Write for a brochure setting down complete details on the new "1960 Series" socket cap screw standards.

HK

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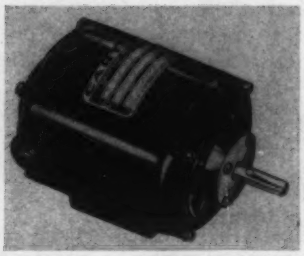
SOCKET SCREWS
THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.



10,000 rpm. Horsepower ratings are 1/10, 1/12, 1/15, 1/18, 1/20, 1/25, and 1/35. Motor is available as universal, shunt, or series type with 12 to 220-v input. **Carter Motor Co.**, 2719A W. George St., Chicago 18, Ill. I

Circle 920 on Page 19

Snap-Acting Switch

subminiature unit withstands 400 F

Subminiature switch is designed for use where ambient temperatures are high and available space is low. Switch is 25/32 in. long x ¼ in. wide x ½ in. high, and withstands temperatures to 400 F continuous. Four USM4 units can be gang-mounted in 1 in. for multiple-circuit control in miniaturized apparatus. In addition to pin-actuator style (shown), switch can be furnished with leaf or leaf-roller actuator. Electrical ratings of the single-pole double-throw switch are: 2.5 amp, 30 v dc, inductive; 5 amp, 30 v dc, resistive; 5 amp, 125/250 v ac. **Unimax Switch Div., W. L. Maxson Corp.**, Ives Road, Wallingford, Conn. B

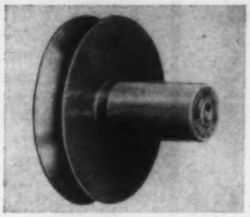
UNIMAX
PAT NO 2,743,33
C
NO
NC

Circle 921 on Page 19

Adjustable-Speed Pulley

provides ratios to 3:1

Adjustable-speed pulley changes speed instantly with fingertip pressure while machine is in motion. It provides ratios to 3:1 at 3⅓ hp and 1150 rpm or 5 hp and 1750 rpm. Both pulley faces move simultaneously and equally to give constant belt alignment; each side is independently actuated by its own spring. Curved pulley faces maintain full contact with belt sides at all times. No. 3050 pulley uses a 1 13/16-in. top width variable-speed belt. Standard bores are 1, 1⅛, 1¼, or 1⅜ in. with 3½-in. bore length. Motor travel for full range is 4⅝ in. with 9.53 in. maximum and 3.17 in. minimum pitch diam. Over-all dimensions are 10 5/16 in. long by 10 in. OD. **Lovejoy Flexible Coupling Co.**, 4882 W. Lake St., Chicago 44, Ill. J



Circle 922 on Page 19

Directional-Control Valve

for 0 to 3000 psi operating pressures

Quick-acting, high-pressure, two-way directional-control valve has low pressure drop, high flow capacity, and positive seal. Design provides sufficient hydraulic balance throughout valve to assure low turning torque for easy valving of fluids. Spherical rotor construction and use of tight metal-to-metal floating seals which are both spring and pressure loaded provide positive sealing over 0 to 3000 psi pressure range. Valve has no external leakage at double rated pressure. Each port is individually attached to body and can be selected, changed, or serviced without special tools. Standard valve is available with ¼,

Another PLUS value...

HIGH-SPEED
CONTAINER
CONVEYING

For container conveying at high speeds, you need Rex Nylon PlateTop Roller Chains. Nylon top plates are simply "snapped on" to extended pins of a ¾-inch pitch roller chain. The smooth nylon carrying surface protects the conveyed articles...cans, bottles, jars or small packages. Chain can be run unlubricated in applications where lubricant stains on containers are to be avoided. Snap-on top plates are made in several widths. For all the facts, mail the coupon.

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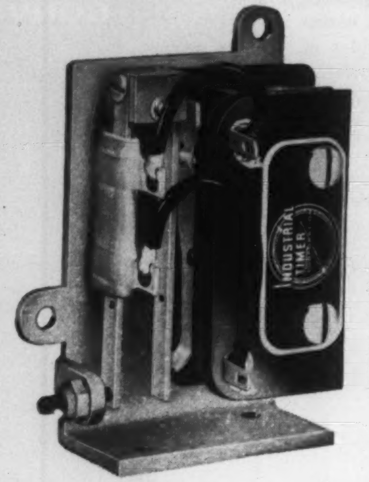
Circle 571 on Page 19



These new developments are just two recent items added to our ever growing line of industrial timing devices which now exceeds 1,700 controls. If you would like more information about the line, drop us a note requesting our general catalogue

NEW! MINIATURE THERMAL TIME DELAY SWITCH

10-20 Amp. Capacity—SNAP ACTION

The new Series TH Timer makes accurate switching control of high current applications *practical* and *economical* for the first time! No more bulky, costly thermal switch and relay combinations . . . no more teasing of load contacts in electro-mechanical circuits from slow make-and-break. The new Series TH Timer's SNAP ACTION contacts give *fast, positive* switching of loads *up to 20 amperes.*

There's a wide choice of contacts, too: SPDT, DPDT, Double Break, Magnetic Blowout DC and others to match your needs.

This new, compact timer automatically compensates for ambient temperature changes, by using two parallel bimetal strips. Longer life comes from the rugged, totally enclosed cast ceramic heater. And you can adjust your time cycle easily with a single screw.

Available in time cycles from 2 seconds to 5 minutes, the new Series TH Timers are the low-cost answer to switching in air conditioning, refrigeration, exhaust and heater controls, computers, lighting, and a host of other applications.

For complete information, write today for Bulletin #900.

NEW! SIMPLIFIED PUNCHED CARD PROGRAMMER

Direct Control from Programmer to Process!

Here's the simple, dependable method of applying true automatic control to most of your manufacturing and operational processes . . . *direct control* of up to 85 individual load circuits through as many as 30 separate functions . . . with permanent, convenient 5″ x 9″ Mylar* punched cards.

Operation from any switch closure makes this electro-mechanical card reader easily adaptable to a variety of control systems, including analog, digital, temperature, feed-back, photoelectric, time and many others. Already in use for a wide variety of industrial and military applications, these flexible units are easily modified to meet your particular requirement.

For more information, write for Bulletin #100.

AFFILIATE — LINE ELECTRIC COMPANY

Timers that Control
the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION
1413 McCARTER HIGHWAY, NEWARK 4, N. J.

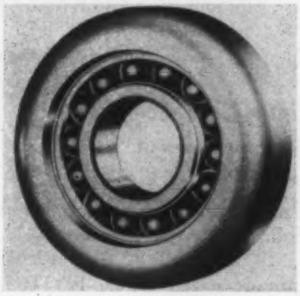
⅜, and ½-in. dry-seal pipe-thread ports. Valve handles oils, noncorrosive fluids, and lubricated air. It can be used for in-line and panel-mounted installations. **Sarasota Precision Products Inc.**, 1314 N. Lime Ave., Sarasota, Fla. O

Circle 923 on Page 19

Ball Bearing

for high radial and axial load conditions

Full-complement ball bearing of through-hardened construction has deep, unbroken, burnished raceways. It is designed for high radial and axial load conditions, such as are encountered in the masts of lift trucks. Bearing, shown unsealed, is made with mechanical seals on both sides. **Heim Co.**, 20 Sanford St. Fairfield, Conn. B



Circle 924 on Page 19

Adjustable-Speed Drives

have speed range of 100:1

Adjustable-speed drives in 1/6 to 10 hp range employ a magnetic amplifier unit driving thyratrons in a full-wave circuit, followed by a dc shunt motor. Speed ranges of 100:1 and regulation percentages of 1 to 2 per cent are attained without tachometer feedback. Modular construction permits choice of features required for particular application. Standard optional characteristics include dynamic braking, reversing, jogging, remote control, torque limiting, and line-voltage compensation. Standard-duty line, Series 25, covers 1/6 to ¾-hp range; heavy-duty line, Series 200, is available in 1/6 to 10-hp range. Series 35, a nonelectric line, is for use where exacting speed regulation is not of prime importance. Available in 1/6 to 3-hp range, drives use adjustable autotransformers and rectifiers. Speed range is 100:1, and regulation is approximately 200 rpm no-load to full load, based on 2000-rpm base speed. **Cleveland Machine Controls Inc.**, 1111 Brookpark Rd., Cleveland 9, Ohio. G

Circle 925 on Page 19

Glass-Fiber Tubing

has high tensile and bursting strength

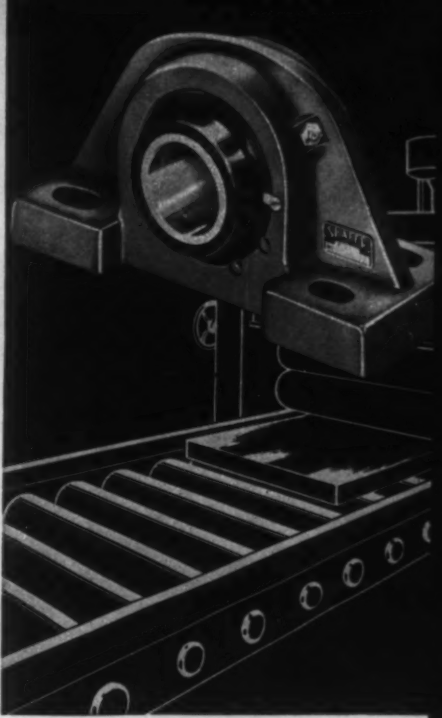
Line of epoxy resin-bonded glass-fiber tubing, designated Phenolite Grade G-11-3680 or G-11-3681, depending upon diameter and wall thickness, is suitable as a material for selected electrical or electronic components. It can be used by itself or in combination with inner and outer layers of other materials, and has high tensile and bursting strength. Tubing is available in diameters from ⅛ to 11 in. ID with wall thickness from 0.01 to 5½ in. Material exhibits very low water absorption, minimum dimensional change, high dielectric strength, high arc resistance, and low power loss over extremely wide frequency range. **National Vulcanized Fibre Co.**, 1059 Beech St., Wilmington 99, Del. C

Circle 926 on Page 19

Explosionproof Motor

is rated ½ hp at 4500 rpm ±5 per cent

Model 38VG3 totally enclosed, explosionproof motor is designed for 200/115 v ac, 400 cps, three-phase operation. Motor is rated ½ hp at 4500 rpm ±5 per cent. Motor oper-



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EASIEST
ON-THE-JOB
INSTALLATION

Shafer Bearings take the "trick" out of on-the-job replacement. Self-aligning, they automatically adjust to unavoidable inaccuracies in mounting or to shaft deflection which is inevitable in normal service.

Under every type of load—radial, thrust or combined—they never lose their high load and shock bearing capacity.

Shafer Bearings always renew the profit-earning capacity of tired equipment. Mail the coupon or see your nearby distributor.

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Circle 573 on Page 19

U Model
P Model with no base
P Model
S Model
Speed Reducers
NEW OHIO LINE
Fin & Fan Cooled

80% More Capacity—Far Less Space

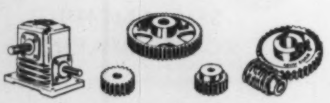
HI . . . in capacity — will handle up to double the load.

HI . . . in versatility—More load with no increase in size or weight.

HI . . . in performance — Fin and fan cooled for greater capacity with less heat rise.

HI . . . in value — all new design for long life and minimum maintenance.

HI-Line reducers are available in six new series ranging from 1.33" to 5.25" centerdistance. Standard models in each series include vertical with high or low base, and horizontal models with worm upper or lower.



Get Your Free Catalog — 186 pages packed with useful information on gears and speed reducers

Manufacturers of gears and speed reducers - both stock and special

Ohio

OHIO GEAR Company
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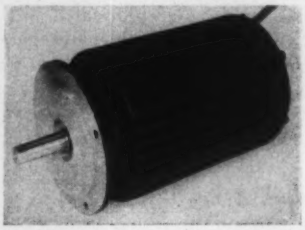
Circle 574 on Page 19



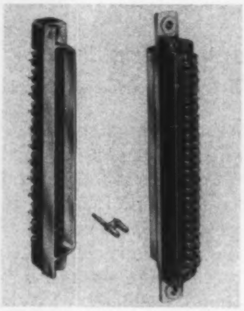
ates at 75 per cent efficiency, requires 4.5 amp. It has minimum of 1000 hr life and incorporates permanently lubricated, shielded ball bearings with corrosion-resistant shaft. Unit is 6.5 in. long and has diam of 4 15/16 in. **Electro Products Div., Western Gear Corp.,** 132 W. Colorado St., Pasadena, Calif. L

Circle 927 on Page 19

Printed-Card Connectors

have two rows of taper pins

Series of printed-card connectors is available in total contacts of 7, 11, 15, 19, 23, and 32, or in custom configurations. UPCC-FDTP connector has two rows of taper-pin terminals linked mechanically and electronically for use with AMP 53 taper pins. Unit is suitable for critical environmental conditions and extremes of military applications. **U. S. Components Inc.,** 454 E. 148th St., New York 55, N. Y. D



Circle 928 on Page 19

Stainless Pipe Unions

for high pressure or high vacuum

Corrosion - resistant, high - pressure pipe unions with wholly confined Teflon seals are rated from 2000 to 6000 psi. They are designed for use where extreme pressures or

Miniature plug-in Relay for printed circuits

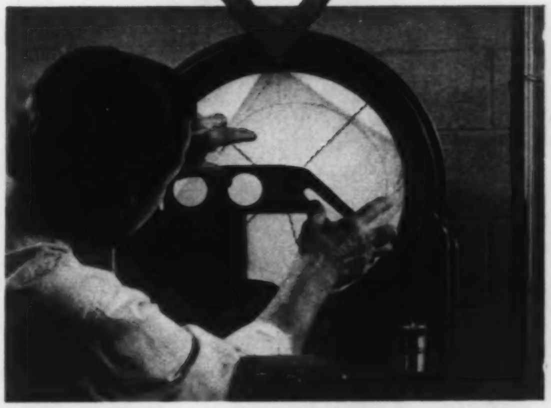
SQPC Relay—Length, 1 3/4″; height, 1 5/16″ to 1 3/4″ (depending upon number of springs); width, 1″.

...millions of operations without attention!

Need a dependable relay for direct insertion into printed circuits? Automatic Electric's new Printed-Circuit Relays run *up to 120 million operations without a single readjustment or relubrication!*

Miniaturized without sacrifice of ruggedness, these *SQPC* Relays, with reinforced mounting, deliver reliable performance under extreme conditions – dependable contact operation at up to 10.5 G's, 25 G's shock, and temperatures from –55° to +85°C.

SQPC Miniature Printed-Circuit Relays are available with many different contact spring arrangements—can be permanently secured with any acceptable soldering technique.



RELAY SPRING TAKING ITS "PHYSICAL." A technician explores critical spring areas for tool marks and concealed defects—calibrating radii to .001 inch—checking for the strength and stamina which will assure long, uniform service life. Automatic Electric quality control is unmatched in the industry—a compelling reason why you should specify AE in your engineering.

Save parts, assembly and wiring time by using printed circuits—and Automatic Electric SQPC Relays. For full details, write or call: Automatic Electric Sales Corp., Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC ®

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Circle 575 on Page 19

ROLLWAY
MADE IN U.S.A.
Choose from types and sizes numbered in the thousands!
ROLLWAY MAXIMUM BEARINGS

. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

ENGINEERING OFFICES:

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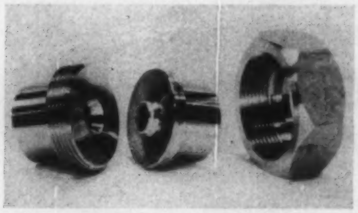
ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

Circle 576 on Page 19



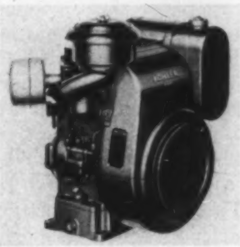
corrosive conditions prevail. Called Koncentrik pipe unions, units have threaded or socket-weld ends of stainless steel that can be welded easily and resist attack from a wide range of corrosive elements. Test with helium indicates unions are also satisfactory for high-vacuum connections. They are for nominal pipe sizes of 1/8 through 2 in. **Special Screw Products Co.,** Bedford, Ohio. F

Circle 929 on Page 19

Heavy-Duty Engine

develops 9.5 hp at 3600 rpm

K-241 engine has spark advance mechanism which automatically retards spark during starting and advances it when speed is increased. Unit develops 9.5 hp at 3600 rpm. Cooling system directs sufficient volume of cool air to maintain correct operating temperatures under all conditions. Standard equipment includes heavy-duty silencer-type muffler, oil-bath air cleaner, and rotating chaff screen. Applications are found in construction, industrial, and agricultural equipment. **Kohler Co.,** Kohler, Wis. K



Circle 930 on Page 19

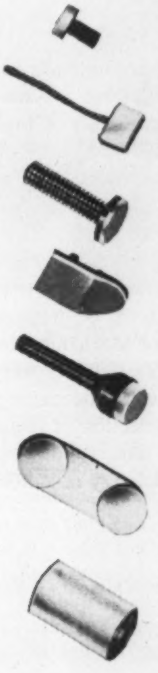
Thermal Time-Delay Relays

for automatic and electronic equipment

Hi-Gee relays conform to all existing MIL specifications including MIL-R-5757 and MIL Standard 202. Available time settings, pre-

"NIX!
We've tried that
contact material before!"

common error in CONTACT SELECTION



Frequently, in recommending contacts, Stackpole meets the objection: "We've tried that grade before. It's no good for our equipment!"

Experience proves that such conclusions should not be reached too quickly. Certainly they should not be based on tests of only one or two contact grades.

For instance, an electrical equipment manufacturer rejected a silver-tungsten grade (made by another contact producer) because of its high contact resistance. Because of this, he ruled silver-tungsten contacts "out" of further consideration.

After considerable persuasion, a Stackpole silver-tungsten grade was finally tested and proved eminently satisfactory. *This grade, however, contained different proportions of silver and tungsten powders. Moreover, it was processed by much different methods.*

Other instances might be cited wherein prejudices against silver-graphite, silver-copper and other so-called "standard" materials were overcome by Stackpole Custom-Tailored contact grades.

Actually, Stackpole's chief contact facility is its proved ability to adapt standard materials to specific equipment. A relatively small percentage change in the metal powders used in a mix plus Stackpole's unique processing methods may make a vital difference in contact performance.

The moral then is simply this: If use of a certain contact material grade is indicated by reasons of economy, potentially desirable characteristics, ease of assembly or whatnot, the failure of one such grade only points up the need for further custom engineering.

And such failures usually provide the clues to Stackpole contact engineers as to what changes need to be made!

Stackpole welcomes the opportunity to supply convincing proof of this to quantity contact users.

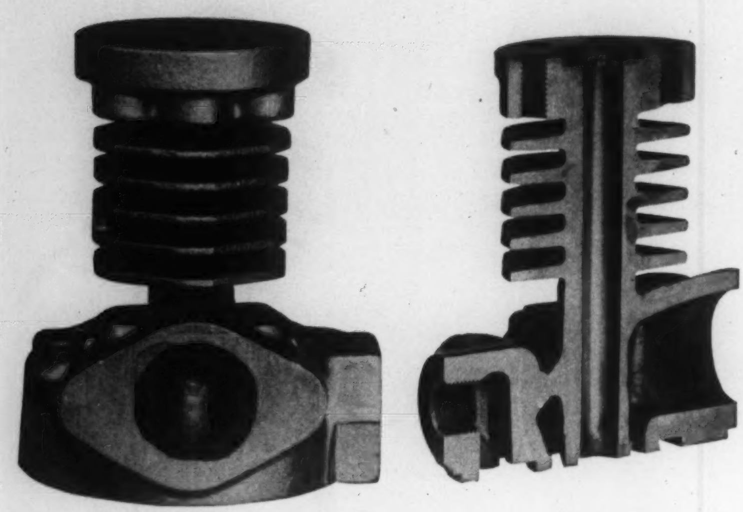
STACKPOLE CARBON CO., *St. Marys, Pa.*

STACKPOLE

Custom-Engineered CONTACTS

Hundreds of grades in SILVER-GRAPHITE • SILVER-LEAD OXIDE • SILVER-NICKEL • SILVER-MOLYBDENUM • SILVER-TUNGSTEN • COPPER-GRAPHITE GOLD-GRAPHITE • SILVER-COPPER-GRAPHITE • SILVER-IRON OXIDE . . . and other special material combinations mixed to exacting specifications and processed from powders.

Circle 577 on Page 19



PRESSURE TIGHT

A CASE IN POINT—This 8 pound Meehanite Metal casting made for the Joy Manufacturing Co. by Hamilton Foundry is a fourth stage air compressor cylinder. Pressures build up to 6,000 p.s.i. and require a high strength, pressure tight and wear resisting casting. Alloyed Meehanite® oil quenched and tempered, raised Brinell hardness of the cylinder wall to 275-300, and increased tensile strength to 60,000 p.s.i. Meehanite was chosen for this casting because controlled structure and small uniform flake graphite produce pressure tight castings of uniform density and strength.

Meehanite is both an iron—and a controlled process. Through the Meehanite Process the microstructure and the quantity and form of graphite is consistently controlled. This means that a specific type of Meehanite can be selected to meet engineered casting requirements. Testing of every ladle of molten iron insures that specifications will be met in the casting.

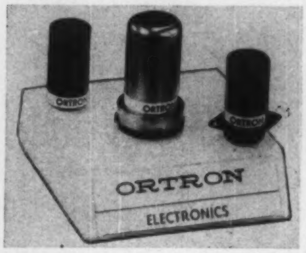
When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY

The Hamilton Foundry & Machine Co., 1551 Lincoln Ave., Hamilton, Ohio • TW 5-7491

Circle 578 on Page 19



set at factory, are ¼ to 180 sec. Time to 300 sec is available on special order. Timing tolerance for relays for 5 to 300 sec is ±10 per cent. Settings from ¼ to 4 sec have 20 per cent tolerance. Relays operate in temperatures from −55 to +125 C. Units with temperature requirements to 150 C can also be furnished. Units are hermetically sealed and are unaffected by altitude or atmospheric conditions. Operating voltages can be supplied from 2 to 230 v ac or dc. Base types available are 7 and 9-pin miniature plug-in, octal, and 7-pin hooked with mounting flange. **Ortron Electronics**, 29 Lincoln Ave., Orange, N. J. D

Circle 931 on Page 19

Laminated Plastic

is flame-retardant and humidity-resistant

XXXP grade laminated plastic for electrical applications is available both in plain sheets, designated Dilecto XXXP-31EFR, and copper-clad sheets, named Di-Clad 31EFR. Plain sheets of cellulose paper impregnated with epoxy resin are used as insulation for computers, radios, telemetering equipment, and guidance equipment requiring permanent flame-retardant properties. Material strongly resists humidity, features excellent cold-punching qualities, and is lighter than epoxy glass-fabric-base laminates. Thickness range is from 0.015 through 0.25 in. in sheet sizes of 38 x 42 in. and 38 x 38 in. Color is natural (cream), and finish is semigloss. The metal-clad material is the same basic material with 1 or 2-oz copper foil on one or both sides. Sheets with 1-oz copper have 9 to 10-lb bond strength, and 2-oz sheets have 10 to 12-lb bond strength. Both 1 and 2-oz types have 465 F hot-solder resistance of 30 sec. Material is used

U. S. ELECTRICAL MOTORS INC. DISCOVERED THAT CELANESE CELLULUBE HYDRAULIC FLUID GAVE THEM MORE THAN FIRE RESISTANCE!

Cellulube 300 also solved problems of sticking valves and line leaks . . . improved overall system efficiency

With ordinary hydraulic fluid, the high operating temperatures of the centrifugal caster at U. S. Electrical Motors Inc. made it essential to add detergent regularly to clean sticking valves. Furthermore, it was necessary to change hydraulic fluid frequently in order to reduce formation of sludge and varnish.

Since converting to Celanese Cellulube 300 in early '57 (primarily to eliminate the hazards of fire due to possible line breaks) it hasn't been necessary to change fluid, nor have sticking valves been a problem. In addition, valve leaks are virtually eliminated.

Celanese Cellulubes . . . the fire resistant hydraulic fluids . . . can minimize the hazard of fire in your plant and improve operating performance. They are available in six controlled viscosities (90, 150, 220, 300, 550 and 1000 S.U.S. at 100°F.) One of these is best suited to your operation. Check with your Celanese representative for full information, or write directly for evaluation sample, stating application involved.

Celanese® Cellulube®

Celanese Corporation of America, Chemical Division, Dept. 565-E, 180 Madison Ave., N. Y. 16.
Canadian Affiliate: Canadian Chemical Company Limited, Montreal, Toronto, Vancouver.
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y

Circle 579 on Page 19

Celanese
CHEMICALS

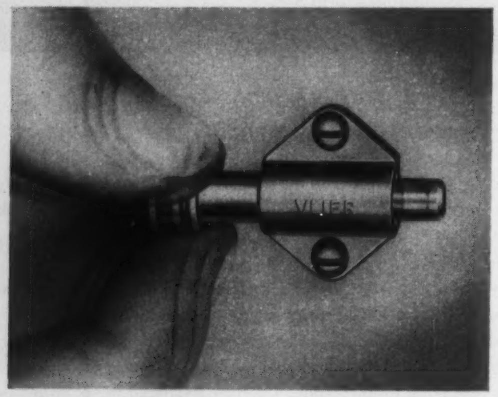
Practical Design Tips

No. 4 of a series

Hundreds of companies are now saving by using off-the-shelf Vlier products like the ones shown below. These simple, low cost, precision parts save designers time and, in many cases, simplify product design and manufacture. Why not investigate their possibilities today.

BALL PLUNGERS WORK BETTER than spring plungers when side loads are involved. Balls won't bind from side thrusts, retract easily. Available in new, "Mini-ball" sizes, down to #4-48x3/16"; standard sizes from #10-32x1/2" to 5/8-11x1". Various end pressures.

TORQUE-LIMITING WRENCH for assembling small parts, adjusting set screws, etc., is easily made from a Vlier Torque Handle and a length of hexagon stock. Prevents over-tightening, and subsequent damage to parts. End pressure is adjustable from 15 to 200 lbs.



NEED A SMALL, LIGHTWEIGHT, SPRING-LOADED LATCH? One enterprising designer modified a standard Vlier S-88 Spring Stop that did the job perfectly. Entire latch weighs less than 1/3 oz. Body is die-cast aluminum; plunger is heat-treated alloy steel. Various plunger pressures. Available on quantity orders only.

typical
applications
of
locking accessories

FREE IDEA BOOKLET. Illustrations in this 16-page booklet show how others have profited from the use of Vlier products. Illustrates both the usual and unusual applications. May suggest ways *you* can save. Write for your copy today.

VLIER
Engineering Corporation
A subsidiary of Barry Controls, Inc.
8900 Santa Monica Blvd. • Los Angeles 46, California

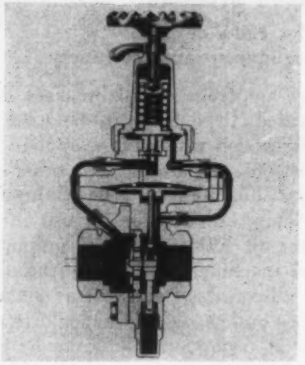
for printed-circuit boards in same equipment as nonclad material, and is 0.032 through 0.25 in. thick in same sheet sizes. Maximum continuous operating temperature for both plain and copper-clad types is 248 F. **Continental-Diamond Fibre Corp.**, Newark, Del. C

Circle 932 on Page 19

Piloted Pressure Regulator

for pressures to 250 psi

Redesigned ½ to 2-in. piloted pressure regulator provides minimum maintenance, tight shut-off, and accurate regulation. It incorporates sliding gate and plate seats, external sensing tubes, Teflon pilot seat, handwheel and thumb-lock, and ball-bearing adjustment. Unit is suitable for pressures to 250 psi and temperatures to 450 F. It is available in bronze, cast iron, and ductile iron with screwed ends, and is for steam, water, air, oil, gas, and chemicals. **OPW-Jordan**, 6013 Wiehe Rd., Cincinnati 13, Ohio. G

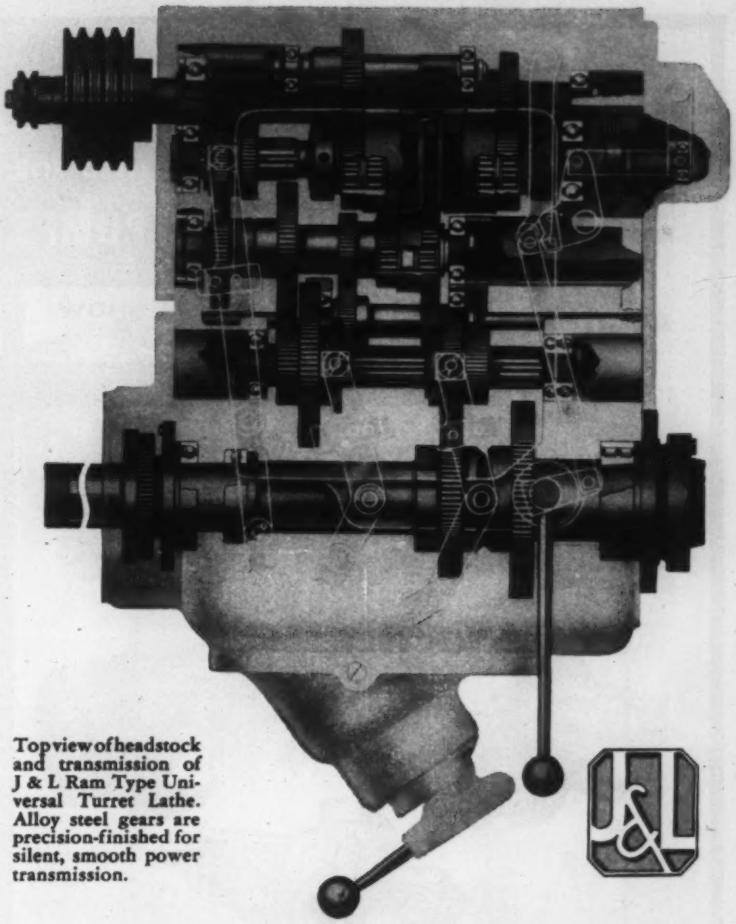


Circle 933 on Page 19

Safety Clutches

slip at preset torques to 300 lb-in.

Line of clutches provides overload protection through slippage at any preset torque up to 300 lb-in. Full drive recurs when torque falls below preset value. Breakaway torque settings are varied easily with threaded adjustor secured with recessed lock screw. Standard clutches are integral with single or double grooved sheaves for A or B belts. Five pitch diameters range from 6.2 (A belt) to 11 in. (B belt). Units fit on shafts up to 1 in. diam and



Top view of headstock and transmission of J & L Ram Type Universal Turret Lathe. Alloy steel gears are precision-finished for silent, smooth power transmission.

J&L

Perkins Gears Used by Jones & Lamson

Jones & Lamson Machine Company, famous as manufacturers of the world's most accurate and powerful turret lathes, use Perkins precision gears for efficient, dependable performance. Perkins custom-cut gears are precision-made to exact specifications. They eliminate wear, noise and backlash. Our OEM customers know Perkins means dependable service and longer gear life. Perkins' long experience in producing precision gears could bring profitable benefits your way, too! Ask our engineers to work with you designing or estimating your next gear order.

WRITE TODAY for folder showing bevel, spiral, helical and spur gears; ratchets, sprockets and ground-thread worms; face gears, generated and curvic clutches; made by Perkins in many sizes from all materials.

Perkins Machine & Gear Co., West Springfield, Mass.

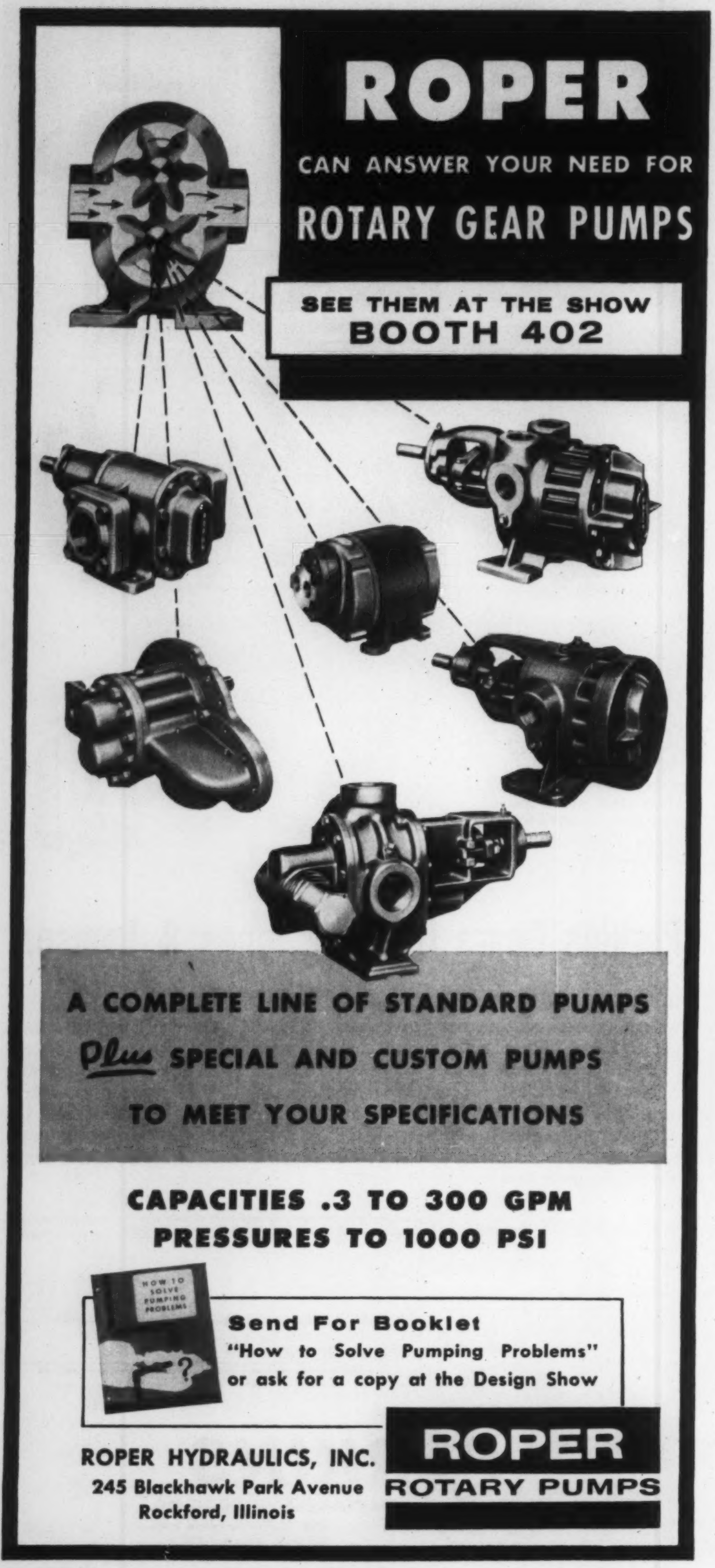
Name____________________________

Company__________________________

Address__________________________

PERKINS
MACHINE AND GEAR CO.
Dept. 43, West Springfield, Mass.
Telephone: REpublic 7-4751

Circle 581 on Page 19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CAN ANSWER YOUR NEED FOR
ROTARY GEAR PUMPS

SEE THEM AT THE SHOW
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A COMPLETE LINE OF STANDARD PUMPS
Plus SPECIAL AND CUSTOM PUMPS
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PRESSURES TO 1000 PSI

HOW TO SOLVE PUMPING PROBLEMS

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ROPER HYDRAULICS, INC.
245 Blackhawk Park Avenue
Rockford, Illinois

ROPER
ROTARY PUMPS

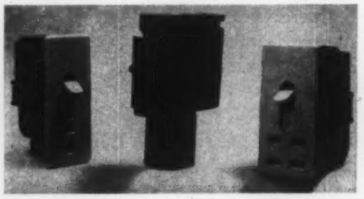
extend $2\frac{3}{4}$ in. along through or stub shaft. Standard sheaves have oil-impregnated bearings with provision for reoiling. **Edgemont Machine Co.**, 2200 Home Ave., Dayton 1, Ohio. G

Circle 934 on Page 19

Circuit Breakers

for 120-v electrical equipment and machinery

Low-amperage circuit breakers, designated Type SA, can be used in conjunction with motors, appliances, electronic apparatus, and other industrial equipment. Rated 5 through 20 amp, breakers are for use on almost all 120-v electrical equipment and machinery. They can be used as disconnects and extra convenience outlets, as well as for external circuit protection. Basic model is a low-amperage unit (center) 11/16 in. wide, $2\frac{3}{8}$ in. long, and $2\frac{1}{2}$ in. deep. Device is available in ratings of 5, 10, 15, and 20-amp. Also available, in 15-amp ratings, are a single-outlet breaker (left) and a double-outlet unit (right). **Federal Pacific Electric Co.**, 50 Paris St., Newark, N. J. C

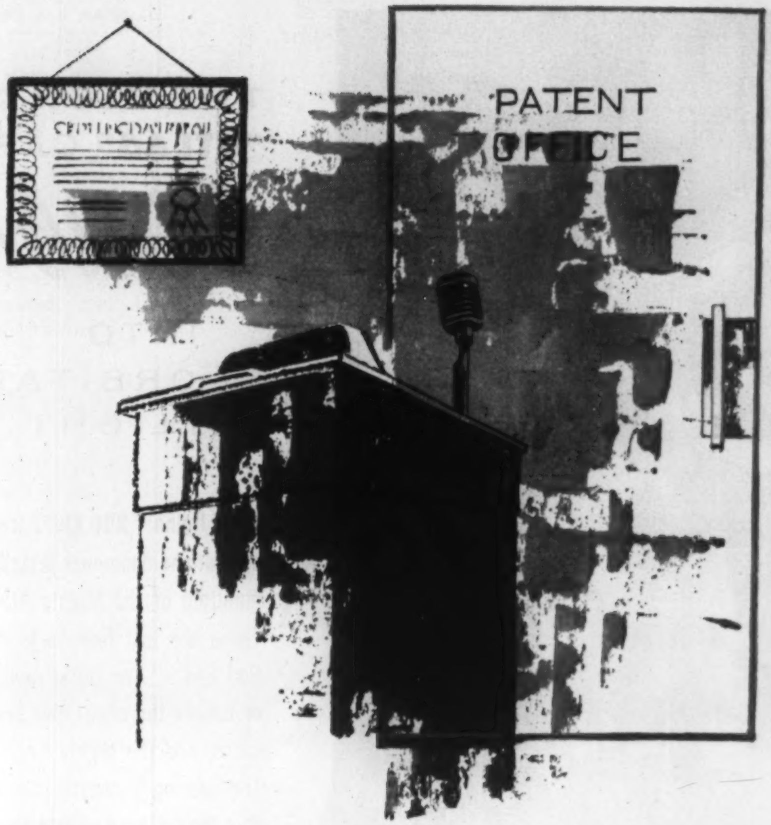


Circle 935 on Page 19

Gear Motors

for heavy, continuous duty

Available in any single speed from $\frac{1}{2}$ to 1000 rpm, heavy-duty gear motors are designed for continuous service. They are furnished in three models: Model HD 4 (1/20



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- Inertial Guidance Systems
- Afterburner Fuel Controls
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- Gyroscopes
- Speed Sensitive Switches
- Speed Sensors
- Torquemeters
- Vibacall
- Skyphone

If you are a graduate engineer in the electronics, electrical or mechanical fields, you are recognized as a *professional* when you work in AC's instrumentation business.

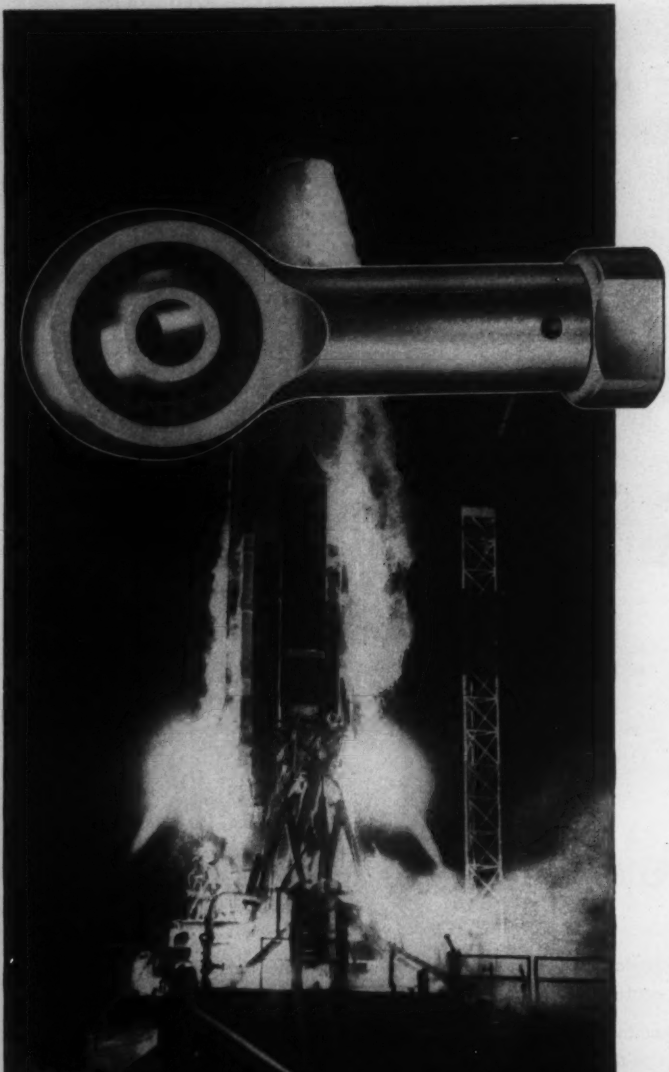
AC encourages you to write and present papers at professional society meetings. What's more, if your original research and experimentation leads to new inventions, AC will assist you in obtaining patents.

You can also enhance your status through advanced training. AC offers three special "in house" programs—for recent graduate engineers, for experienced engineers and for engineering supervisors. These practical courses constitute AC educational "extras" and are second to none in the country. They're offered in addition to the AC and General Motors educational assistance programs for men who wish to take additional studies in nearby universities.

These are just a few of the advantages you'll enjoy while you work on AC's famous AChiever inertial guidance system or a wide variety of other electro-mechanical, optical and infra-red devices . . . for today and the "space age."

Step into the "space age" with the greatest name in industry . . . General Motors. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

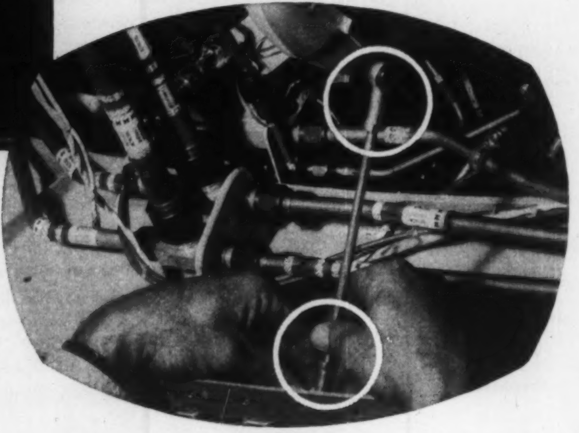


THE MIGHTY "ATLAS" CARRIES *Unibal*® INTO ORBITAL ...FLIGHT........

HEIM Unibal® ROD ENDS are used in the linkage for the dampener installation on the fuel manifold of the Mighty Atlas.

There are just four parts to a Heim Unibal Rod End . . . an outer member (either male or female threaded), two bronze bearing surfaces, and the highly finished sphere (ball). The bearing is constructed in such a fashion that the ball is used as a swaging die in forming the bearing surface, and coins a corresponding finish into the mating surface. Upon completion, the ball is free to turn in any direction within the outer member. Weight is kept to a minimum, heavier loads can be carried with this simplified construction, and misalignment is universally corrected.

The Mighty Atlas is built and test-flown for the U.S. Air Force by Convair (Astronautics) Division of General Dynamics Corp.



This is just one of many operations performed by Heim Unibal bearings on the Mighty Atlas. They are completely dependable and their ease of assembly is evident in this photo.

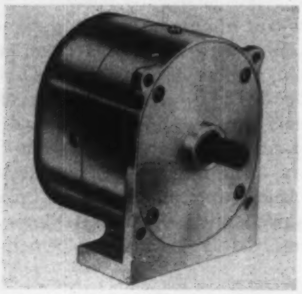
The Heim Engineering Department can offer suggestions to help solve design problems requiring high-capacity, self-aligning bearings and rod ends, particularly in mechanical linkages. Write for catalog or engineering advice.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

Circle 584 on Page 19

hp) provides 175 lb-in. torque at 10 rpm; Model HD 2 (1/30 hp) provides 80 lb-in. at 10 rpm; Model HD 1 (1/65 hp) provides 40 lb-in. at 10 rpm. Units have ball-bearing motor, generated gears and pinions of hardened steel, and large felt oil reservoir touching every journal. Motors can be either base or panel mounted, and are totally enclosed with continual airflow over motor. Two-pole, shaded-pole motor is free from radio and television interference. Standard voltages is 115 v, cycle ac, with special cycles and currents also available. **New England Gear Works,** 557 South End Rd., Southington, Conn. B

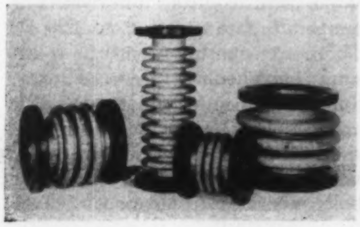


Circle 936 on Page 19

Bellows Expansion Joints

for applications at temperatures to 750 F

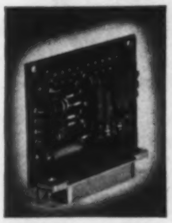
Stainless-steel bellows expansion joints are available in 3 to 30-in. nominal pipe sizes for applications to 275 psi and temperatures to 750 F. They are for use where factors such as restricted space or high costs make it impractical or uneconomical to use conventional offsets and loops to handle strains brought about by thermal expansion or contraction of piping material. Applications include use in nuclear energy, shipbuilding, textiles, rubber, plastics, metals, aircraft, coal, paper and pulp, food



Now! A higher reliability factor in printed circuits

ALTORI

a new and distinctively different finish on TAYLOR copper-clad laminates that accepts all acid resists uniformly



Something new and distinctively different has been added to TAYLOR copper-clad laminates — a finish that accepts all types of acid resists uniformly. High fidelity in printed circuit reproduction is assured. Circuits can be of consistently higher quality and reliability, no matter how critical the design. For complete details about TAYLOR copper-clad laminates and samples, write TAYLOR FIBRE CO., Norristown 47, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

Circle 585 on Page 19

Get
STRONG, NEAT ASSEMBLIES
without threading, notching or drilling for cotter pins

Use plain, unthreaded rods, shafts, studs, rivets or pins and simply Push on these low-cost

PUSHNUT®
FASTENERS

Type W PUSHNUTS

One-piece, heavy gauge spring steel with powerful gripping action. Cover rod ends with smooth, rugged cap. Always align perfectly. Hold tight seated or unseated. Various designs and finishes in sizes for 3/16", 1/4", 5/16", 3/8", 7/16" and 1/2" dia. unthreaded rod, wire and studs.

All PUSHNUTS apply manually or with high speed air hammers

Type U PUSHNUT Retainers

New low-cost, space-saving spring steel retainers push on plain rod or axle, providing strong, firm retention of parts, seated or unseated. Eliminate notching, grooving, drilling and cotter pins. Available for 5/16" and 3/8" dia. rod; other sizes in development.

Send for Free Samples and Data, stating type, size and application

Flat Type H PUSHNUTS

Easily, quickly pushed on unthreaded studs to assure tight, vibration-proof assembly of ornaments, medallions, nameplates and other parts. Grip tight on hard chrome studs. Sizes for 1/16", 5/64", 3/32", 1/8" and 3/16" dia. studs.

Acorn Type PUSHNUTS

Pleasing, decorative appearance and strong spring grip for fastening or covering ends of rods, studs or rivets. Open end and closed end types. Six sizes from .120" to .312" dia.

THE PALNUT COMPANY, 75 Glen Road, Mountainside, N. J.
In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS PAL

Quick, secure fastening at low cost

Circle 586 on Page 19

processing, mining, heavy construction, rail and marine terminals, pneumatic conveyors, missiles, processing equipment, and machinery. **Chemetron Corp., Tube Turns Div.**, Louisville, Ky. G

Circle 937 on Page 19

Timing Motor

heavy-duty unit
is moistureproof

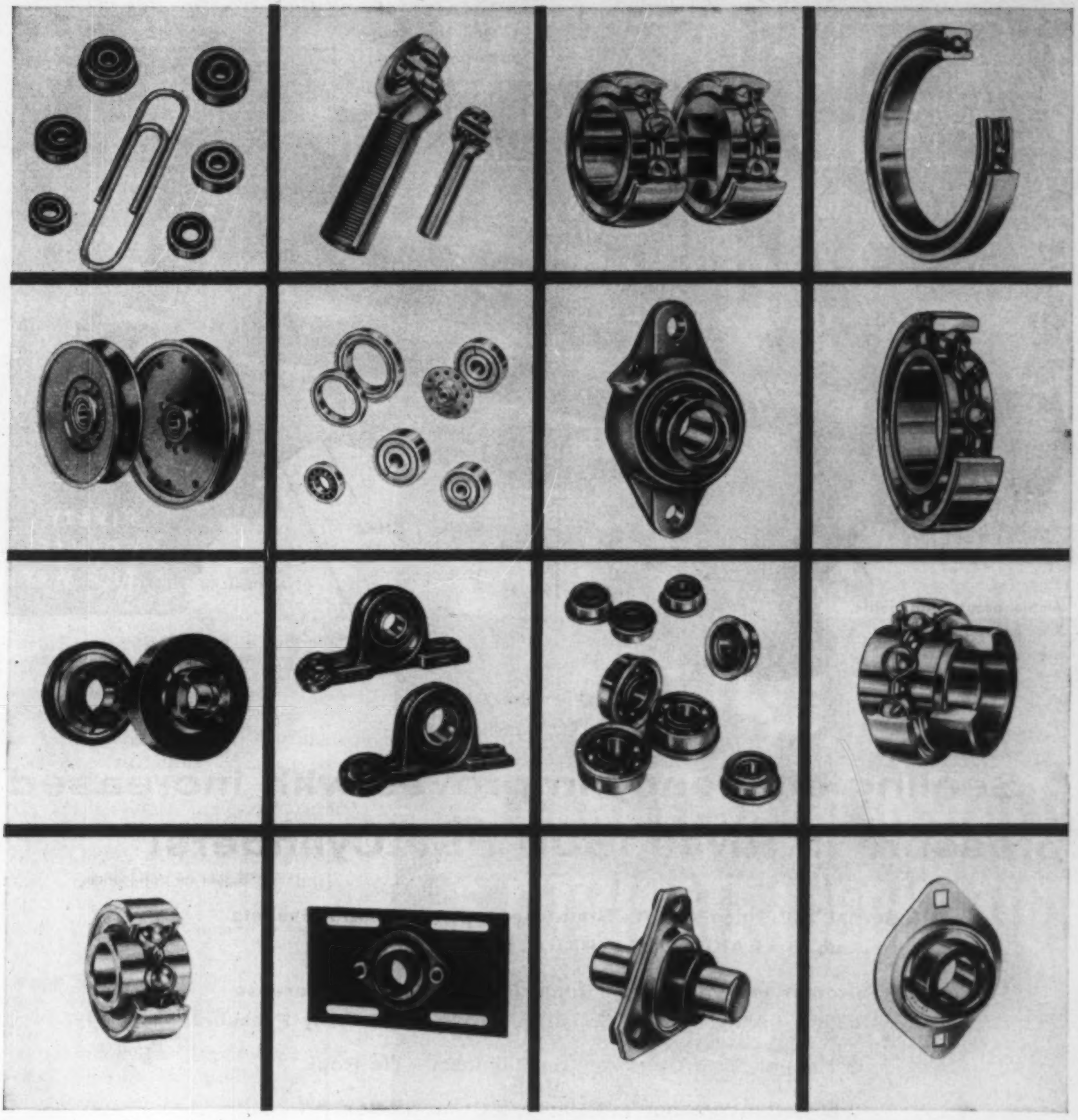
Low-cost timing motor is designed for chart drives, timing devices, and other similar applications. Designated MP11, timing motor is completely covered and sealed against entrance of moisture, except at shaft opening, which is protected by mounting motor on a plate equipped with a gasket. Motor is a heavy-duty, permanent, synchronous type with guaranteed torque of 30 oz-in. at 1 rpm. Synchronization is maintained over range of 103 to 132 v ac. Unit is available for 120 or 240-v operation at 50 or 60 cps. Standard shaft speeds are available between 1/60 and 60 rpm. **Haydon Div., General Time Corp.**, 245 E. Elm St., Torrington, Conn. B

Circle 938 on Page 19

Temperature Controller

for temperatures from
0 to 600 F

Thermistor sensing probes feed into a transistor amplifier in Model 535 temperature controller. Designed for single-point control, unit covers a temperature range of 0 to 600 F. Thermistor sensing elements, solid-state components with virtually unlimited life, can be remote mounted, and connections can be uncompensated standard electric wiring. Unit, surface mounted with two screws or bolts, contains transistor amplifier,



NEW FOR TODAY'S DESIGN NEEDS . . .
16 FAFNIR BALL BEARING DEVELOPMENTS!

See them at Fafnir Booth 1236, Design Engineering Show

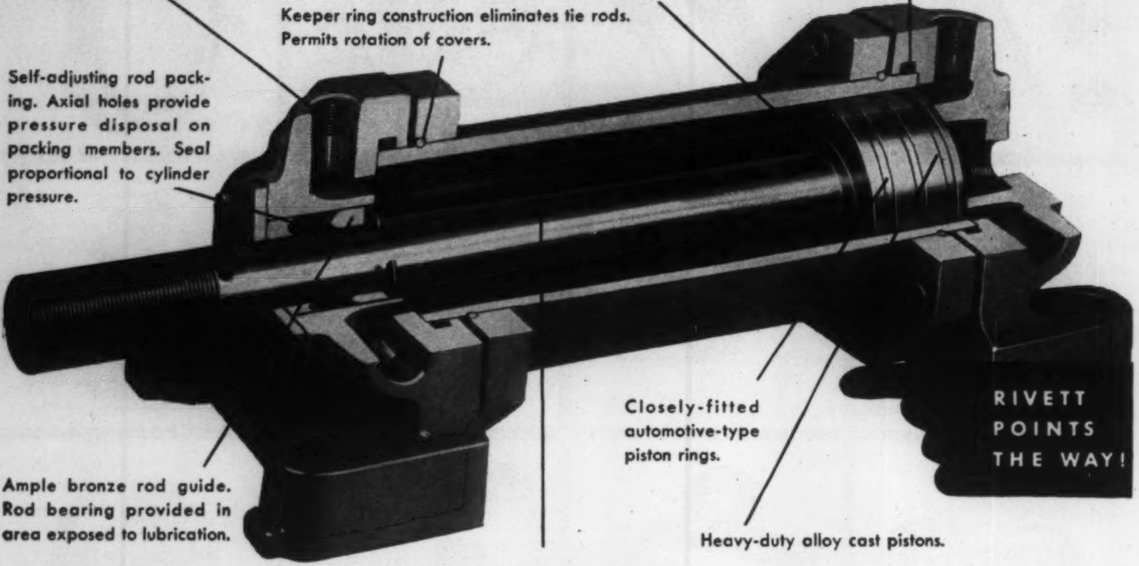
The "midget" bearings in the upper left hand corner are Fafnir's new vacuum melt stainless steel miniatures. The pillow blocks are the modern-design LSA and LSAO. At bottom right are space-saving versions of the famous Fafnir Flangette.

Other units include Fafnir special-precision control bearings for high-speed aircraft — an industry "first". Also, ball bearings for air conditioning equipment, farm equipment, precision mechanisms, machinery . . . sixteen new bearing designs all told, all introduced within the past few years.

One or more of these new Fafnir ball bearing developments could be your answer to improved product performance. Have "the man from Fafnir" show you what's new for *you* in the line that "keeps a step ahead" of industry's requirements. The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS
Progress in Motion

Circle 587 on Page 19


Large pipe connections.
Keeper ring construction eliminates tie rods. Permits rotation of covers.
Alignment of piston rod and assembly assured by close-fitting pilot and shoulder.
"O" ring seals. No gaskets required.
Self-adjusting rod packing. Axial holes provide pressure disposal on packing members. Seal proportional to cylinder pressure.
RIVETT POINTS THE WAY!
Closely-fitted automotive-type piston rings.
Ample bronze rod guide. Rod bearing provided in area exposed to lubrication.
Heavy-duty alloy cast pistons.
Seamless drawn steel tubing, precision honed.

Sealing efficiency improves with increased pressure in Rivett 1500 PSI* Cylinders!

*Higher on application.

- External "O" Rings Act As Static Seals To Eliminate Gaskets And Assure LEAKPROOF OPERATION!
- Automotive Type Piston Rings Reduce Friction, Increase Sealing Ability, Permit Sensitive Response To Any Pressure.
- Keeper Ring Construction Eliminates Tie Rods.
- Self-Adjusting Rod Packing Cuts Friction.
- Unfailing Power For Millions Of Cycles.

1080 SELECTIONS!

7 mountings; 10 bores; standard and 2:1 over-size rod; single and double end rods; internal or external thread; cushioning either or both ends; special covers.

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Brighton 35, Boston, Mass.

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Hydraulic Cylinders

Get Catalog No. 106 to aid your circuit design. Complete drawings, specifications, cut-away views, tables, diagrams!

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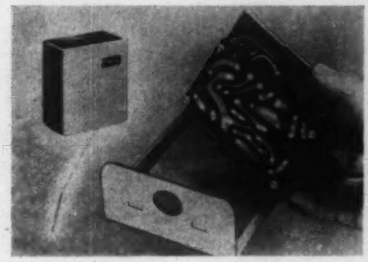
THE BETTER YOU KNOW HYDRAULICS
THE BETTER YOU LIKE

RIVETT
"100"
HYDRAULIC CYLINDERS

Circle 588 on Page 19



dial for temperature control point adjustment, and relay to apply power to heaters, alarms, or other external loads. Contact capacity is 5 amp, 115 v ac, SPDT. **Fenwal Inc.**, Pleasant Street, Ashland, Mass.
B

Circle 939 on Page 19

Insulated Rod

for high torque applications

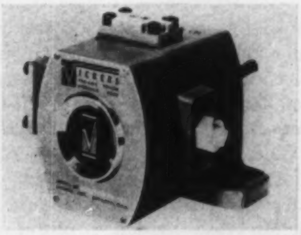
High-strength, paper-base laminated-plastic sheathing is adapted to the insulation of aluminum or steel rods for use under high torque. Sheathing accepts multiple setscrew mountings of components without chipping or cracking. Sheath is solidly anchored to metal rods. Rods are available in a range of lengths and diameters, in varying degrees of insulation thickness. **Richardson Co.**, 2860 Lake St., Melrose Park, Ill.
J

Circle 940 on Page 19

Vane Pump

for pressures to 1000 psi

Variable-delivery, 5-gpm hydraulic vane pump for use in industrial applications includes an integral pressure compensator which controls pump volume at preselected adjustable pressures. Designed for pressures to 1000 psi, pump limits its delivery to system demand. Maximum delivery is limited by means of a mechanical adjustment, and pressure compensation can be varied from 200 to 1000 psi. Sharp



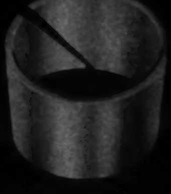
Circle 589 on Page 19→

LONG LIFE, *THOMSON* "Snap-In"

NYLINERS

of smooth, tough DuPont NYLON

Low Cost
FLANGED Nyliner



Low Cost
SLEEVE Nyliner

Low Cost
DOUBLE-FLANGE Nyliner

• • • BETTER BEARINGS THAT... • • •

• COST LESS to BUY*

• COST LESS to INSTALL

& ELIMINATE LUBRICATION

Additional Benefits:

- CLOSE FIT
- LONGER LIFE
- EASILY INSTALLED
- LESS SERVICING
- SELF-RETAINING
- RESIST CORROSION
- LOW FRICTION
- RESIST POUNDOUT
- NO FRICTION OXIDATION
- DAMP VIBRATION
- OPERATE IN LIQUIDS
- NON-CONTAMINATING
- INSTANTLY REPLACEABLE
- RESIST ABRASION
- MINIMUM SPACE
- SILENT OPERATION
- LIGHTEST WEIGHT
- REDUCED WEAR

Engineered to Solve Problems . . . Improve Products . . . Reduce Costs!

NYLINER Bearings are a highly engineered thin liner of DuPont Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

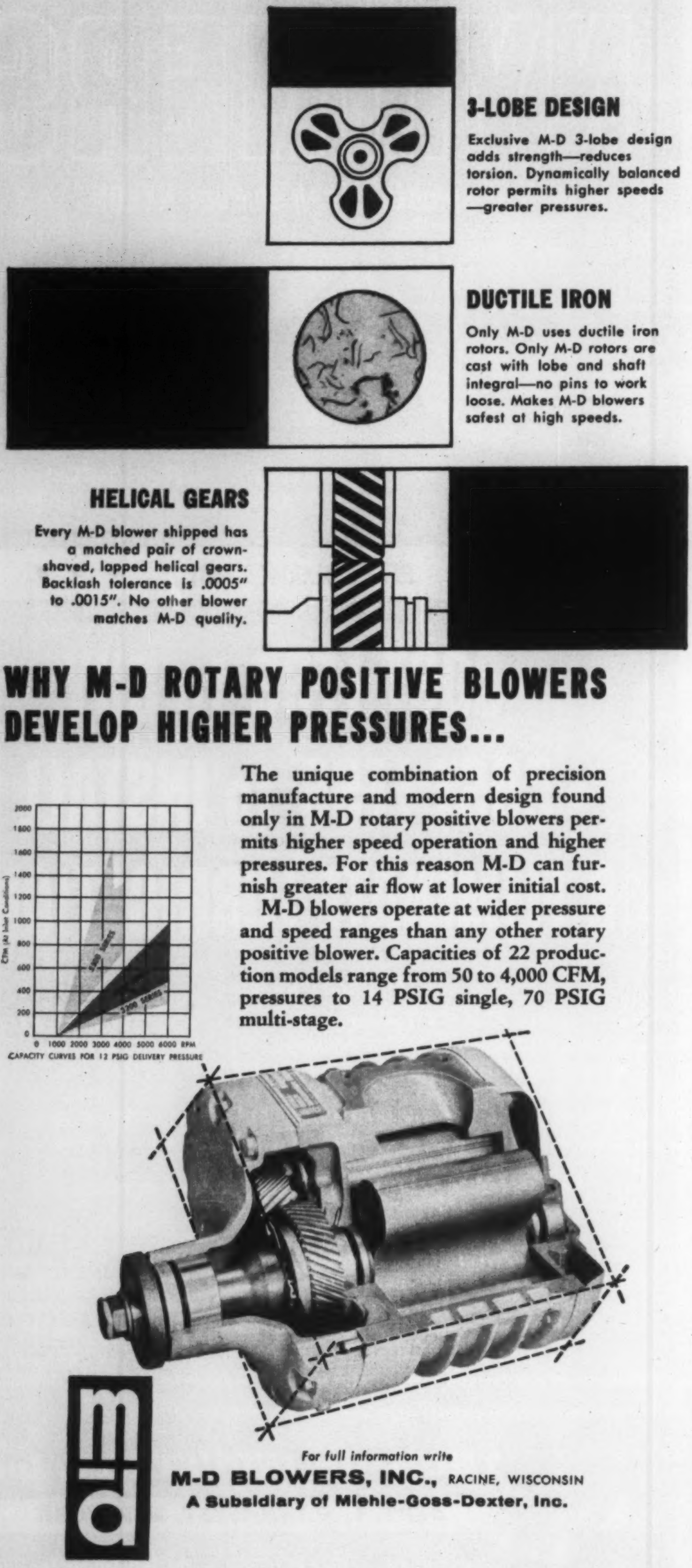
Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.

**In production quantities at new, REDUCED PRICES.*

THOMSON INDUSTRIES, Inc.

DEPT. 4, MANHASSET, NEW YORK

Also—Manufacturers of BALL BUSHINGS . . . the Ball Bearing for Linear Motions and 60 CASE . . . Hardened & Ground Steel Shafting


3-LOBE DESIGN

Exclusive M-D 3-lobe design adds strength—reduces torsion. Dynamically balanced rotor permits higher speeds—greater pressures.

DUCTILE IRON

Only M-D uses ductile iron rotors. Only M-D rotors are cast with lobe and shaft integral—no pins to work loose. Makes M-D blowers safest at high speeds.

HELICAL GEARS

Every M-D blower shipped has a matched pair of crown-shaved, lapped helical gears. Backlash tolerance is .0005" to .0015". No other blower matches M-D quality.

WHY M-D ROTARY POSITIVE BLOWERS DEVELOP HIGHER PRESSURES...

The unique combination of precision manufacture and modern design found only in M-D rotary positive blowers permits higher speed operation and higher pressures. For this reason M-D can furnish greater air flow at lower initial cost.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 14 PSIG single, 70 PSIG multi-stage.

CAPACITY CURVES FOR 12 PSIG DELIVERY PRESSURE

For full information write

M-D BLOWERS, INC., RACINE, WISCONSIN

A Subsidiary of Miehle-Goss-Dexter, Inc.

Circle 590 on Page 19

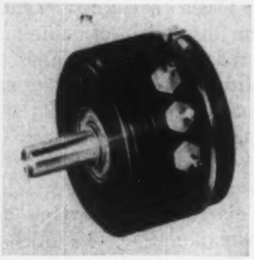
cut-off characteristics enable unit to deliver nearly full volume up to compensator setting even at low operating pressures. Nominal 5-gpm rating is at 1800 rpm. Pump is available for flange, foot, or gasket mounting. **Vickers Inc., Div., Sperry-Rand Corp.,** Detroit 32, Mich. H

Circle 941 on Page 19

Precision Potentiometers

in resistance ranges from 55 to 115,000 ohms

All-metal, 1 7/16-in. precision potentiometers have power rating of 4.5 w at 40 C, derated to 0 at 150 C. Small, single-turn units, designated Series 5400, are available in resistance ranges from 55 to 115,000 ohms. Standard linearity is ±0.5 per cent, and tolerances as low as ±0.15 per cent can be supplied on special order. Nonlinear versions are provided without external padding. Potentiometers have either sleeve or ball bearings, and shaft speeds to 240 rpm cause no damage. Ball-bearing units have standard torque of 0.6 oz-in., with 0.25 oz-in. also available. Applicable sections of NAS 710, JAN-R-19, and MIL-E-5272A are met or exceeded. **Helipot Div., Beckman Instruments Inc.,** 2500 Fullerton Rd., Fullerton, Calif. L



Circle 942 on Page 19

Air Motor

combines three components in one compact unit

Air Motor consists of air power cylinder, electrically actuated control valve, and built-in speed controls. Installation requires one air-line connection and simplified wiring to solenoid-actuated, pilot-operated valve. Compact, square-head cylinder has a rustproof body and induction case hardened piston rod

with hard chromium-plated finish. Control valve is reciprocating-disc type that operates when blanketed by chips or grinder dust, or when splashed with coolant. Easily adjusted speed controls are built into the four-way valve port plate and provide accurate adjustment of cylinder piston speed in both directions. Motors are available in five bore sizes and choice of stroke length. **Hannifin Co.,** Dept. 116, Des Plaines, Ill. J

Circle 943 on Page 19

Vinyl Wiring Duct

is available with mirror finish

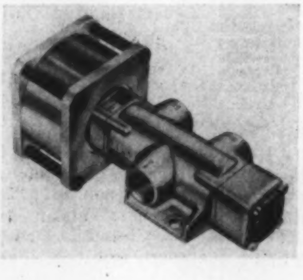
Rigid vinyl duct possesses high impact strength, oil and acid resistance, and easy fabrication properties. Duct has high-gloss mirror finish which reflects light into corners and behind components, making wiring and servicing easier. It is available in standard mirror-finish grey or black, and in bright colors to special order. **Taylor Electric Inc.,** 15400 Dale, Detroit 23, Mich. H

Circle 944 on Page 19

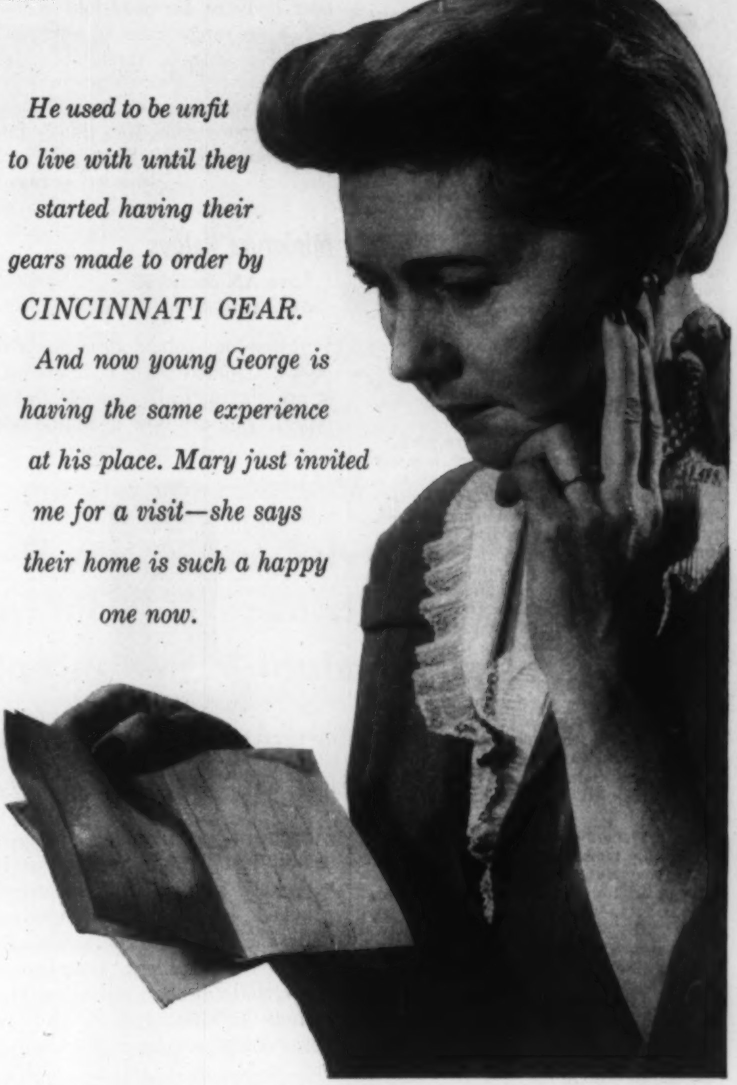
Diaphragm Valve

for use where pilot pressures are low

New diaphragm valve meets need for a low pilot-pressure actuator in instrumentation and automation applications. Valve can be actuated by pilot pressures as low as 5 psi on double-diaphragm types and 10 psi



My George was like that...



He used to be unfit to live with until they started having their gears made to order by CINCINNATI GEAR. And now young George is having the same experience at his place. Mary just invited me for a visit—she says their home is such a happy one now.

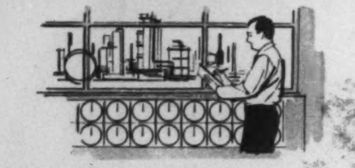
Guaranteed quality and reliability of product through the years have earned for us a long list of thoroughly satisfied customers. Send prints of your custom gear and gear box requirements for quotation.

CINTI

THE CINCINNATI GEAR CO.

Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907
GEARS, good gears only

Circle 591 on Page 19



SPECTROL PRECISION MECHANISMS

One Man, Black Boxes, and Process Control

Speeding up instream process control frequently requires more ingenuity than cash.

Bearing on this point, Spectrol recently made a number of cleverly engineered black boxes for one of the country's leading refineries. This device, known as an Indicating Process Monitor, takes inputs from flow, temperature, and pressure transducers, measures them and delivers any necessary corrective action through a servo loop. The information is visually presented on dials incorporating adjustable set points. Output from this Spectrol black box also drives a variety of data handling, display, and recording equipment.

Here's how it works. After a given physical quantity is transduced to a voltage, it passes through a difference sensing network to a servo-amplifier. The amplifier output voltage operates a motor and speed reducer which drives several Spectrol precision potentiometers ganged on a common shaft. The output voltage of one of these potentiometers has a linear relationship to the indicator setting and is used for negative feedback. The difference between this voltage and the transducer input voltage becomes the servo error signal. Rotation of the system continues until the error signal becomes zero and the indicator reads the new value of the physical quantity under consideration. Meanwhile, other potentiometers on the shaft send voltages to various instream control devices which raise and lower pressures, temperatures, and so forth until the process takes place at the desired rate. Static accuracy is 0.2%.

The visual monitoring task of the observer is simplified by mounting the meter on an easily rotated chassis so that anticipated output in terms of arbitrary units from 1 to 100 can always be read with the needle in an upright position. This feature minimizes observer error where several predetermined outputs are viewed continuously. If black box A is set at 85, B at 40, and C at 100, the operator merely rotates each Spectrol precision mechanism until the respective needle reads the value in an upright position. He can quickly note and correct any processing circuit that leaves boundary conditions.

Of course, these devices are readily adaptable to the more esoteric tasks of reading fuel flow, pressure and temperature in a missile launch blockhouse. Here, human engineering of visual displays is of vital concern.

In a nutshell, advantage of this instance of Spectrol's unique approach to automation is a package one-fifth the size for 40% less than the way the refinery used to do the same job.

More information, including a helpful 8 page booklet, on this and other Spectrol precision mechanisms designed for use as functional sub-systems is yours for the asking. Simply call your nearest Spectrol sales engineering representative or address Department. 575

8

SPECTROL

ELECTRONICS CORPORATION

Sales engineering representatives in principal cities.

1704 S. DEL MAR AVE., SAN GABRIEL, CALIFORNIA

Circle 592 on Page 19

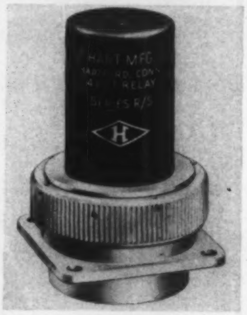
on standard spring-return models. Small-capacity control valve is required to operate diaphragm valve. Valve is available with either sideport body or for manifold mounting. Sizes range from $\frac{1}{8}$ through 1 in. NPT in two, three, four, and five-way types. Valve is for pressures from partial vacuum to 500 psig. **Versa Products Co. Inc.,** 249 Scholes St., Brooklyn 6, N. Y. D

Circle 945 on Page 19

Miniature Relays

have AN connector mounting arrangements

Sensitive four-pole, double-throw relays, designated Series R/S, are miniature, hermetically sealed aircraft types. They are now available with AN-type connector mounting arrangement which makes wiring-assembly installation and field service extremely simple, while connector provides a seal against moisture and assures positive connection. Relays have excellent temperature, shock, and vibration resistance. Uses include missiles, ground and airborne computers, jet-engine controls, and automation control systems. Standard contact ratings include: 30 v dc; 115 v ac; 2, 5, 7½, and 10 amp resistive; 2 and 5 amp inductive. Coils are available with resistances of 1 to 50,000 ohms. **Hart Mfg. Co.,** 110 Bartholomew Ave., Hartford 1, Conn. B



Circle 946 on Page 19

Indicator Lights

miniature units meet MIL-L-6723 (ASG)

Two series of miniature indicator lights which feature two-terminal isolated ground circuits, anodized

(Advertisement)

Eastman 910 Adhesive solves another production bottleneck

New Plastic Corporation, Los Angeles, manufactures light, attractive hammers as part of an all-purpose tool kit, called "Diligent Duchess," designed specifically for housewife or career girl.

To assemble the hammer, a molded plastic adapter on the end of the glass fiber handle is coated with a small amount of Eastman 910 Adhesive and immediately rammed into the steel forged head.

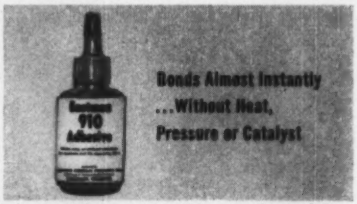
Within minutes, the bond is strong enough to permit packing for shipment.

The adhesive-bonded hammer withstands 300,000 blows successfully, indicating a service life expectancy three times normal.

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins *immediately.* With most materials, strong bonds are made in minutes.

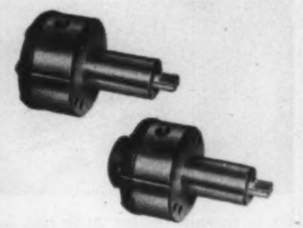
What production or design problem can this unique adhesive solve for you?



For a trial quantity (⅓-ounce) send five dollars to Armstrong Cork Company, Industrial Adhesives Division, 9105 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Division, Dept. M-5, Kingsport, Tenn.

Circle 593 on Page 19

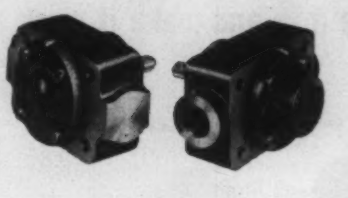
NOW! Have Reliable Lubrication at Minimum Cost



Models LF and RF

Capacities 55-170 g.p.h. at 1800 r.p.m.

Designed for flange mounting without shaft seal; with *choice* of internal or external porting. Model RF has automatic reversing feature which permits driving the pump in either direction...without changing direction of flow or port positions.



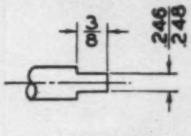
Models LFD and RFD

Capacities 60-180 g.p.h. at 1800 r.p.m.

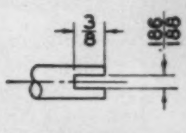
Designed for non-directional service; for flange mounting with internal porting. Variations for external porting and/or shaft seal are shown below. Model RFD has the automatic reversing feature which permits driving the pump in either direction...without changing direction of flow or port positions.

ALTERNATE SHAFT DRIVE ENDS

For All Models



MODIFICATION "A"



MODIFICATION "B"

Tuthill "Cartridge-Type" Pumps Solve This Problem for Plant Maintenance...and Original Equipment Manufacturing

Durable—Reliable—and Available from Stock!

1. The demand for minimum cost lubrication pumps without sacrifice in performance, durability and reliability is *ideally* satisfied by the TUTHILL series of Models LF, RF, LFD and RFD *cartridge-type* pumps.

2. TUTHILL "cartridge" pumps get their reputation as cost-savers from their special design for original equipment use, their durable construction, their reliability...and the fact that they are *available from stock*. Note their compact size as shown in the photos above. Consider how all waste space has been eliminated for more adaptability. Think how they can be easily applied to your *own* requirements...in your plant...or in your equipment manufacturing plans.

3. These variables are available:

- **a.** Pumps with...*or without*...automatic reversing performance
- **b.** Pumps with...*or without*...a shaft seal
- **c.** Pumps with internal...*or external*...porting
- **d.** Pumps with *variations* of both internal and external porting

4. TUTHILL Catalog Section 108 contains line drawings showing each model in detail, shaft rotation and porting arrangements and other vital statistics to help you select the RIGHT model. Fill out the attached coupon—or write.

TUTHILL PUMP COMPANY
953 E. 95th Street, Chicago 19, Illinois

Gentlemen:

☐ Please send me Catalog Section #108
☐ Please send the complete catalog on the Tuthill line
☐ Have your representative call

NAME________________TITLE________

COMPANY____________________

ADDRESS____________________

CITY__________ZONE____STATE________

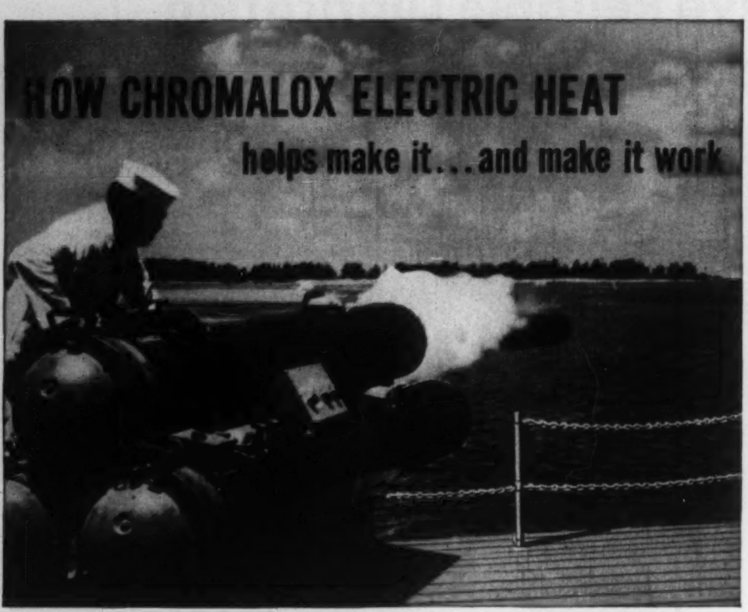
Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities from 1 to 200 GPM, for Pressures to 600 PSI, Speeds to 3600 RPM.

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

PUMPS FOR YOUR PURPOSE

HOW CHROMALOX ELECTRIC HEAT helps make it...and make it work



...the U.S. Navy's new Mark 32 fibre-glass torpedo launcher

From its unlikely beginning as a fibre-glass mat . . . to its successful operation in sub-freezing sea spray . . . the Mark 32 torpedo launcher testifies to the versatility and dependability of Chromalox electric heat. Designed and built by Apex Reinforced Plastics, division of White Sewing Machine Corp., this lightweight, corrosion-resistant launcher is now in service on Navy destroyer escorts.

Early in production, a Chromalox-heated hood is used in centrifugal molding of the launcher tubes.

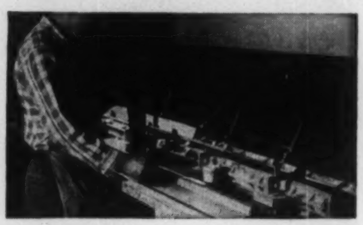
First, a rolled fibre-glass mat is placed inside the mandrel, which is then engaged in spinning motion at 800 rpm. After thermosetting resin has been sprayed into the mandrel, the hood is lowered into position for heat curing. The Chromalox type RAD Far-Infrared Heaters have a total capacity of 36,600 watts, and work reaches approximately 200°F. in about 45 minutes. The hood remains on a total of about 3½ hours, throughout the spinning operation.

Before final assembly, each tube must have steel "nut bars" and "guide bars" cemented to its interior. (Nut bars connect the three tubes into one assembly; guide bars guide torpedoes into the launcher tube.) After these parts are cemented in place, two Chromalox Tubular Heaters wired in series set the cement.

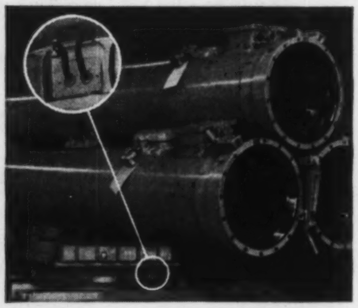
Mounted in a frame which holds them in the center of the tube for its entire length, the 240-volt, 2750-watt heaters are controlled by a Chromalox type AR Thermostat. A small fan attached to the end cap circulates heat within the tube and eliminates condensation.

Next, four plastic quadrants are bolted to the tube interior, forming a liner to accommodate 12¾-inch torpedoes. To each quadrant are affixed two 101-inch Chromalox Flexible Woven Heaters.

After resin has been applied to the two channels in each quadrant, heaters are laid in place as shown below. The leads are then connected to a power outlet and the heaters set the cement which bonds them in place. In action, these heaters maintain a protective 50°F. minimum temperature for the torpedo.



The closeup below shows two leads of a circular Chromalox Tubular Heater clamped in a groove around the launcher's swivel base. To prevent formation of ice in the joint between fixed and rotating parts of the base, this heater comes on automatically when the temperature drops below 50°F.



Plastic bottles, containing air at 2000 psi, provide pneumatic force to launch the torpedoes. Fabrication of these bottles, by the unique Apex filament winding process, involves still another Chromalox Heat application. After the plastic bottle has been formed around a Cerro-alloy ball mold, the alloy must be melted from the bottle's interior. Four sets of Chromalox Strip Heater Bands and a Chromalox Ring Heater provide booster heat on the steam-heated vat used for this purpose.

Perhaps one of these heaters, or one of the 15,000 other types, sizes and ratings of Chromalox Heaters can answer your need for heat. For personal assistance and specific recommendations, *Call your Chromalox Man for the Answers*. He's listed at the right.

7787

CHROMALOX
Electric Heat
INDUSTRIAL · COMMERCIAL · RESIDENTIAL
EDWIN L. WIEGAND COMPANY
7578 THOMAS BLVD., PITTSBURGH 8, PA.

Call Chromalox
for the man with the Answers to your heating problems

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Applebee-Church, Inc.
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Trinity 5-7244

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J. V. Calhoun Company
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Mohawk 4-6113
Greenwood 3-4477

BALTIMORE 18, MD.
Paul V. Renoff Company
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Hopkins 7-3280

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R. P. Smith Co., Inc.
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New York: Worth 4-2990

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Amherst 5-3862

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Fred I. Tourtelot Company
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Harrison 7-5464

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Prospect 1-7112

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L. R. Ward Company
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DAVENPORT, IOWA
Volco Company
215 Kahl Building
Phone: 6-5233

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E. & M. Equipment Co.
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Glendale 5-3651
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Melrose 5-5313

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Fraser D. Moore Co.
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Montgomery Brothers
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Main 4-7297

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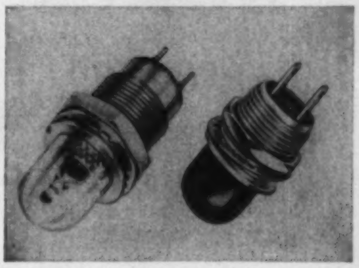
Howard 3-2748

WICHITA 2, KAN.
Fraser D. Moore Co.
Room 211 Derby Building
352 N. Broadway
Amherst 2-5647

EXPORT DEPARTMENT
1010 Schaff Building
Philadelphia 2, Pa.



aluminum cases, and large-area plastic lenses which afford bright, 180-deg visibility meet MIL-L-6723 (ASG). Designed for use with midget flange-base AN3140-type incandescent lamps, Series L14,000 measures only 1-11/64 in. over-all length. It is available with lenses in a variety of translucent and transparent colors. Slightly longer, Series L15,000 features built-in resistor and accommodates NE2D neon lamps for 115-v operation. Lenses are available in transparent red, amber, and clear. Both lights contain positive-locking indexing tabs for panel mounting. Center lamp contacts are internally spring-loaded and insulated with jam-proof nonhygroscopic insulation. **Hetherington Inc.**, Delmar Drive, Folcroft, Pa. E

Circle 947 on Page 19

Nylon Pressure Tubing

can be used continuously at temperatures to 225 F

Flexible polyamide tubing, called Nylaflow Grade TR, has an expected life of 2 to 5 years in water at temperatures to 150 F. It can be used continuously in an oxidizing atmosphere at temperatures to 225 F and can be exposed intermittently to temperatures to 300 F. Material has higher burst strength, and is more flexible than standard Nylaflow. It resists higher temperatures and has longer life in water. Tubing is available in ⅛, 3/16, ¼,

HOW
to make Screwstick your own

Profit Improvement Program

Look here

at how quickly and easily Screwstick loads into a power driver. Just insert Screwstick and the entire stick of screws feeds automatically. Improves profit because Screwstick can cut assembly time in half.

Look at the one-hand operation you get with Screwstick. Operator can position parts with one hand, fasten with the other. Constant measured torque produces uniform tightening. Send for a free sample of Screwstick — another example of the way you benefit from American's Profit Improvement Program.

Look here

Profit Improvement Program

Buy here

The Biggest News in Fasteners comes from
American
SCREW COMPANY
Willimantic, Conn.
Detroit, Mich.
Chicago, Ill.

Circle 596 on Page 19

Special GEAR BOXES a problem?

This **horizontal gear reducer** is Sewall-built for unusually rugged service. Sewall engineers thrive on special and unusual requirements. Tell us yours!

Announcing!

Whether you need gear boxes such as this worm gear reducer in custom or mass produced quantities, it will pay you to talk to Sewall.

For the complete service . . . design . . . development . . . manufacturing . . . on **special gear assemblies** (sample illustrated) call Sewall.

A new Sewall Service . . . designing, development and manufacturing . . . to help solve your special gear box problems . . . effectively . . . economically. We're ready to work with you at any stage of your project's development.

From scratch . . . our gear box designers will go to work for you right now. Give us a rough outline of your idea. We're staffed and equipped to design and manufacture gear boxes whatever the size and description of your requirements.

To your specifications . . . let us submit our quotation on producing your order in strict accordance with your prints. Sewall gear boxes are made by men who are fussy about specifications. Your order must be delivered as scheduled . . . priced right. Let us hear from you!

Sewall's complete gear service can help you . . . custom made gears . . . made-to-order sprockets . . . special gear racks—to order . . . standard gear racks in stock.

E. B. SEWALL MANUFACTURING COMPANY
705 Raymond Avenue, Dept. A, ST. PAUL 14, MINNESOTA, Midway 5-7721

Circle 597 on Page 19

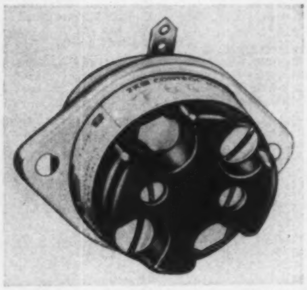
5/16, and $3/8$-in. OD sizes. It is abrasion and impact resistant and can be used readily with standard metallic flare or compression fittings. **Polymer Corp. of Pennsylvania,** 2140 Fairmont Ave., Reading, Pa. C

Circle 948 on Page 19

Thermostatic Switch

operates at setting without drift

Applicable to a wide variety of temperature applications, Temtrol Type A control is a compact electric switching device which makes or breaks an electrical circuit on a change in temperature. It is adaptable to applications such as dishwashers, incinerators, laboratory ovens, aircraft defrosters, electric heating panels, and defrost equipment for commercial refrigeration. Wide variety of models is available to fit requirements for differential, temperature settings, sensitivity, and environment. Control operates at a selected setting without drift, because of practically zero friction and minimum effect of vibration. Electrical ratings are: noninductive, 2500 w at 120/240 v ac; motor duty—4.4 amp full load, 26.4 amp locked rotor, 120 v ac, and 2.2 amp full load, 13.2 amp locked rotor, 240 v ac. Pilot duty is 125 va, 120/240 v ac. **Industrial Div., Penn Controls Inc.,** Goshen, Ind. J

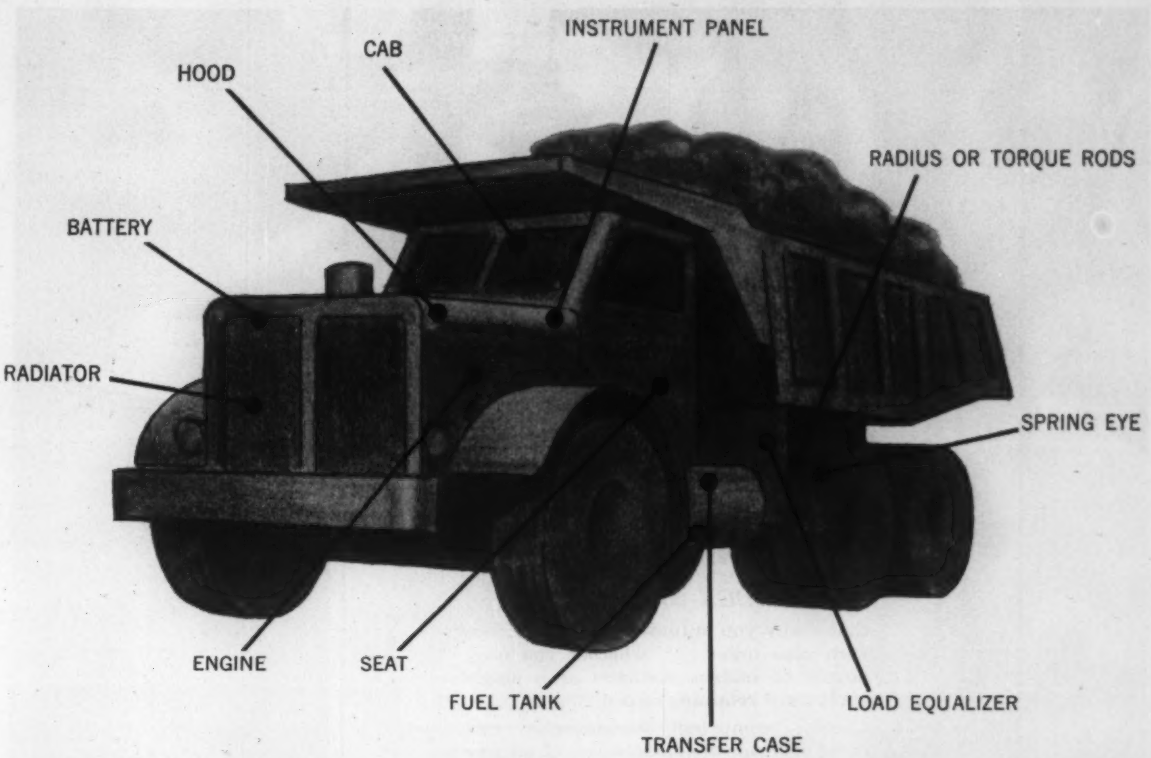


Circle 949 on Page 19

Rotary Torque Actuator

provides high-torque rotation of 0-370 deg

Powered by air, gas, water, or oil, rotary torque actuator seals tight and will not back off under tension, shock, vibration, or complete power failure. Design incorporates



critical points for shock and vibration control

Engineered protection against shock and vibration pays off in *better performance*, *longer service life* and *less maintenance*. This is the experience of a growing number of off-highway, construction and farm equipment manufacturers.

By using flexible LORD Mountings and Joints at key points, they eliminate the efficiency-destroying effects of brutal jolts, vibration, distortion and misalignment.

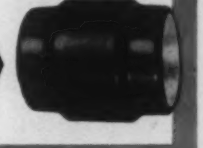
LORD elastomeric units provide positive cushioned action under severe conditions, outlast metal units and never need lubrication. Tough, service-proved flexing elements are specially compounded elastomers, permanently LORD-bonded to steel members. Design is simple and compact, requires no close tolerances, usually fits existing mating parts.

LORD Mountings and Joints are economical, can be specially engineered by LORD to your specific application. Their use eliminates need for "beefing-up" structures, thus permitting increased payloads.

Take advantage of LORD's unsurpassed experience—contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.

Center Bonded Mountings provide flexible support for components, absorb heavy shock loads, isolate vibration and accommodate relative motion without loss of stability. Also feature high unit load capacity and patented rebound protection. Ask for Bulletin 712.

Dynaflex® Joints are long-lasting, lubrication-free bearings or pivots. They accommodate torsional and angular motion, absorb shock and reduce noise and wear. Ask for Bulletin 713.



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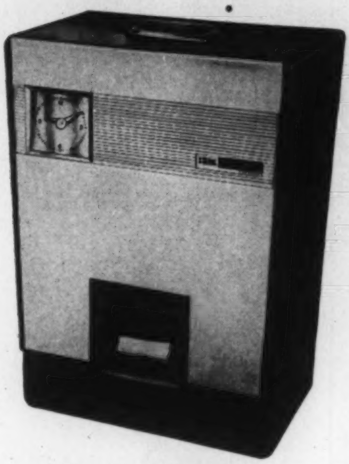

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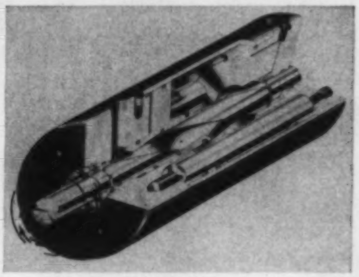
full cushioning as standard in providing 0 to 370 deg of high-torque rotation. Unit can be stopped at any point in rotation cycle. Full cushioning provides smooth, controlled deceleration at end of either clockwise or counterclockwise rotation cycle. Extra 5 deg rotation at end of either cycle permits utilization of full quadrants of rotation in all standard rotation cycles. Standard cycles are 0 to 100, 0 to 190, 0 to 280, and 0 to 370 deg. Applications include positioning, indexing, cam actions, valve operations, swing motions, and agitation. Rotary torque output ranges from 0 to 15,000 lb-in., depending on input pressure and bore size of unit. Number of mounting styles are available, including foot and front or rear flange. **Carter Controls Inc.**, 2914 Bernice Rd., Lansing, Ill. J

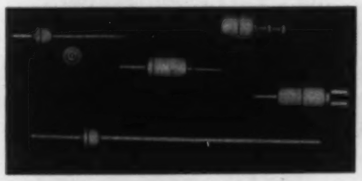


Circle 950 on Page 19

Teflon-Insulated Terminals

are subminiature stand-off and feed-through units

Installed in an electronic chassis by being pressed into prepunched or predrilled holes, Kwik-Term space-saving, Teflon-insulated terminals are furnished in a variety of subminiature stand-off and feed-through type. Teflon material of insulator, when pressed into a mounting hole slightly smaller than its diameter, tends to relieve its own stress. Rivet-type action is caused in Teflon, which anchors and seals terminal in chassis. No nut, washer, staking, or soldering is required. Wide variety of finishes, colors, and



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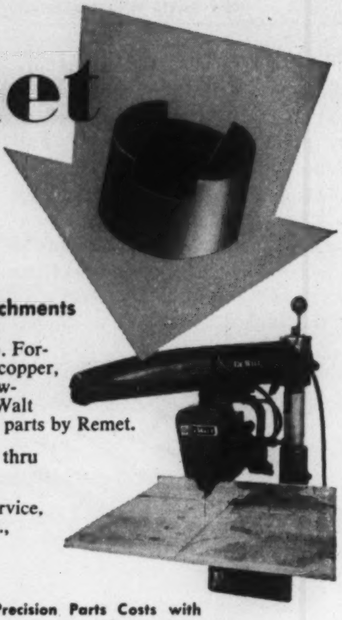
Circle 600 on Page 19

11 Remet POWDERED METAL PARTS

now go into
DEWALT POWER SAW
and attachments



- This Remet collar reduced part cost 80%. Formerly a precision casting in beryllium copper, it is now a Remet copper infiltrated powdered iron part. Advantages led to DeWalt specifying 11 different powdered metal parts by Remet.
- DeWalt now offers greater saw accuracy thru maintenance of closer tolerances.
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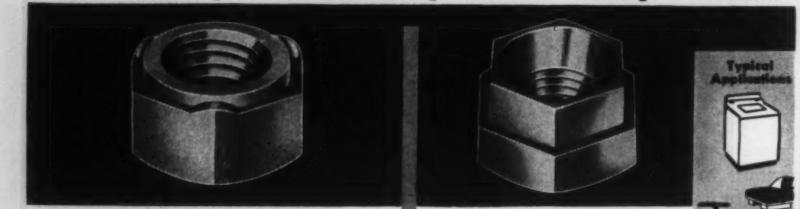
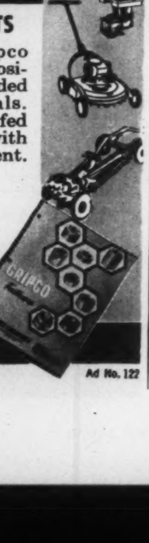
Circle 601 on Page 19

Use These GRIPCO NUTS

FOR "FIXED" and "BLIND" fastening to get

★ Easier Positioning ★ Quicker Fastening ★ Positive attaching ★ Less cost





GRIPCO PILOT-PROJECTION WELD NUT

The centering pilot provides quick, easy positioning of nut in pre-punched hole for instant resistance welding. No jigs, no fumbling, no waste of time. No fouling of threads. In two pilot and projection heights with or without the Gripco Locking feature. Sizes No. 6 thru ⅝".

GRIPCO COUNTERSUNK WELD NUT

Countersunk feature eliminates time-wasting re-tapping of nut after welding. The 3 weld projections on both type nuts provide a firm non-rocking electrical connection.

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With or without Gripco locking feature, for positive attaching of a threaded medium to thin metals. Can be automatically fed and clinched or staked with hydraulic or air equipment.

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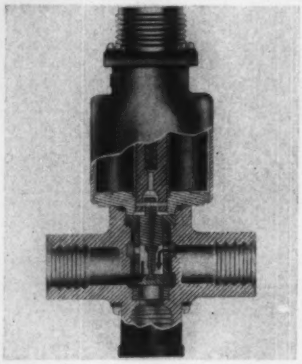
Circle 602 on Page 19

soldering lugs can be supplied. Voltage ratings (sea level) range from 2380 to 4250 v, depending on size of terminal. Standard pin material is silver-plated brass. Available lengths range from 0.12 to 2.5 in., and standard pin diameters from 0.04 to 0.078 in. **Cannon Electric Co.**, 3208 Humboldt St., Los Angeles 31, Calif. L

Circle 951 on Page 19

Solenoid Valve

provides pilot control for larger valves



Direct-operating, three-way, two-position solenoid valve with short response time handles fuels, oils, air, and other gases. Valve can be used to provide pilot control for larger valves. To activate, solenoid requires 1 amp maximum at 14 to 30 v dc when handling pressures to 1000 psi. In ⅜-in. line size, control weighs 0.89 lb. Operating temperature range is −65 to +350 F, fluid or ambient. Pressure drop is 0.12 psi at 200 lb per hr fuel flow. Designated No. 30-1988-000, valve is adaptable for operating temperatures to 500 F and for higher pressures. It can be made in a variety of line sizes for different flow capacities. **Areo Supply Mfg. Co. Inc.**, Corry, Pa. F

Circle 952 on Page 19

Midget AC Solenoid

provides maximum power for small assemblies

Small size of No. 24 ac solenoid permits use in miniaturized systems or wherever space is limited. Only ⅞ in. high x 1¼ in. long x 1 in. wide, unit provides maximum power

BARDEN SR3SSX8 MADE IN USA

Barden Precision SR3SSX8 bearings as used in a synchro transmitter/receiver.

BARDEN *functional testing assures precision performance*

The SmoothRator, an electronic performance tester, was developed by Barden to check vibration as a measure of overall functional quality. A standard quality control instrument at Barden, the SmoothRator is also used by many leading component and systems manufacturers.

Precision-built synchros require small, uniform air gaps and consistently low torque to provide accurate response to a generated signal.

Barden Precision low torque bearings assure the required air gap by close control of radial play and concentricity. The SR3SSX8 has an extra large O.D. which eliminates the need for end caps, increasing air gap accuracy and reducing synchro complexity and cost.

From research and design, through quality controlled production, functional testing and application engineering each *Barden Precision* bearing is planned for performance. *Barden Precision* means not only dimensional accuracy but performance to match the demands of the application.

Barden Precision bearings must pass rigid functional tests on the SmoothRator, the Torkintegrator and other Barden-developed or standard test devices. This functional testing is your assurance of consistent precision performance.

Your product needs *Barden Precision* if it has critical requirements for accuracy, torque, vibration, temperature or high speed. For less difficult applications, Barden *predictable* performance can cut your rejection rates and teardown costs.

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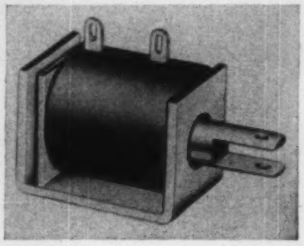


for small assemblies. It is available for intermittent or continuous-duty operation. Plunger stroke is adjustable from 1/16 to 5/8 in. with maximum lift of 12 oz, continuous duty, and 19 oz, intermittent. Coil voltages range from 6 to 230 v ac. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill. J

Circle 953 on Page 19

Teflon Tape

is easily fusible

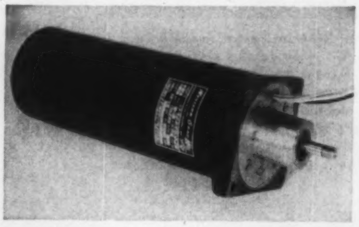
Korabond Teflon tape is a bondable, skived tape which is easily fusible without using adhesives or chemical treatments. A sintered and skived tape, it can be wrapped on wire, and heated to over 620 F so that it completely bonds to itself and solidly shrink-fits to wire conductor. Tensile strength is about 30 per cent higher than that of regular skived Teflon tape, and dielectric strength in volts per mil is about 25 per cent higher. Tape is available in widths to 4 in. in thicknesses of 0.0005, 0.001, 0.002, 0.003, and 0.004 in. Other thicknesses are available upon request. **Dixon Corp.**, Bristol, R. I. B

Circle 954 on Page 19

Gear Motor

is 24-v dc, three-speed unit

Totally enclosed, explosionproof motor is rated 1/10 hp at 1920, 1440, and 960 rpm with ±1 per cent variation. It is a 24-v dc, cen-



You can machine them with confidence

When gears are made from Bethlehem forged-and-rolled blanks, machinists often report faster progress and a better finished job. The blanks are so sound, and have such excellent grain flow, that even the "touchiest" machining can be done with confidence.

Asked what he likes best about these blanks, a veteran production man answered, "They're easy to machine. When you're cutting teeth, you need metal that's clean and solid all the way through."

But there's another important advantage—*strength*. Bethlehem's forging-and-rolling process, unduplicated anywhere, assures the high strength always needed for heavy-duty products. Because of this, the blanks are unsurpassed for gears, crane and sheave wheels, turbine rotors, flywheels, pipe flanges, and other circular parts. Available heat-treated or untreated, they can be furnished in sizes from 10 to 46 in. OD. Write for Booklet 216.

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Circle 605 on Page 19

we're not sure (yet)

- ✓ WHAT YOU CAN USE THIS RELAY FOR
- ✓ HOW MUCH IT WILL COST
- ✓ EXACTLY WHAT THE STANDARD OPERATE & RELEASE VALUES WILL BE
- ✓ THAT THE SPECS, SIZE AND SHAPE WON'T CHANGE
- ✓ THAT IT WILL EVER GET INTO PRODUCTION

we are sure

- ✓ THAT THIS IS A DC VOLTAGE OPERATED, SPDT, HIGH RELEASE, DEVELOPMENTAL RELAY
- ✓ RELEASE CAN BE ADJUSTED UP TO 95% OF SPECIFIED OPERATE VOLTAGE (FROM 6 TO 24 VOLTS)
- ✓ IT WILL SWITCH 2 AMPERE RESISTIVE LOADS AT 28 VDC/120 VAC ON LESS THAN 500 MW. OF SIGNAL
- ✓ IT WOULD BE DANDY FOR MONITORING & CONTROLLING VOLTAGES IN AUTOMATIC BATTERY CHARGERS, POWER SUPPLIES, FILAMENT CIRCUITS, BATTERY-OPERATED TV SETS
- ✓ THAT CONTACT PRESSURE IS NOT DEPENDENT ON COIL SIGNAL
- ✓ THAT IT IS NOT SUITABLE FOR MILITARY ENVIRONMENT APPLICATIONS
- ✓ THAT IT'S KNOWN AS THE SERIES 111 RELAY AND THAT A SAMPLE IS AVAILABLE AT A PRICE

DEVELOPMENTAL

Maybe you twiddled the knob on the display of this relay in our booth at the last Old Campground meeting. If so, we hope you noticed on the meter just how close operate and release values can be. If you think you might be able to use such a relay, we'll gladly send additional particulars, with sure and not so sure portions clearly marked.

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89 Pearl St., So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO. (Since 1939)

Circle 606 on Page 19

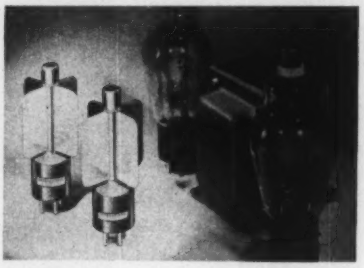
trifugally governed, controlled, three-speed gear motor which meets latest military specifications for camera and tape applications. Motor is adaptable to a wide range of speeds in accordance with requirements. It measures 6½ in. long by 2 5/16 in. diam. **Electro Products Div., Western Gear Corp.,** 132 W. Colorado St., Pasadena, Calif. L

Circle 955 on Page 19

Silicon Rectifiers

for communication and commercial applications

Designed to replace Type 866 mercury-vapor rectifier tubes and filament transformers, high-voltage silicon cartridges provide two-thirds reduction in space and weigh less than one-sixteenth of equivalent tube circuitry. Rated at 6400 peak inverse voltage, units provide dc output currents of 250 ma at 75 C ambient temperature. Applications include radio, television, airline, police, and other communication and commercial applications. Housing and cooling fins of the multiple-junction, hermetically sealed units act as a heat exchanger to dissipate inherently low internal power losses of silicon. **International Rectifier Corp.,** 1521 E. Grand Ave., El Segundo, Calif. L

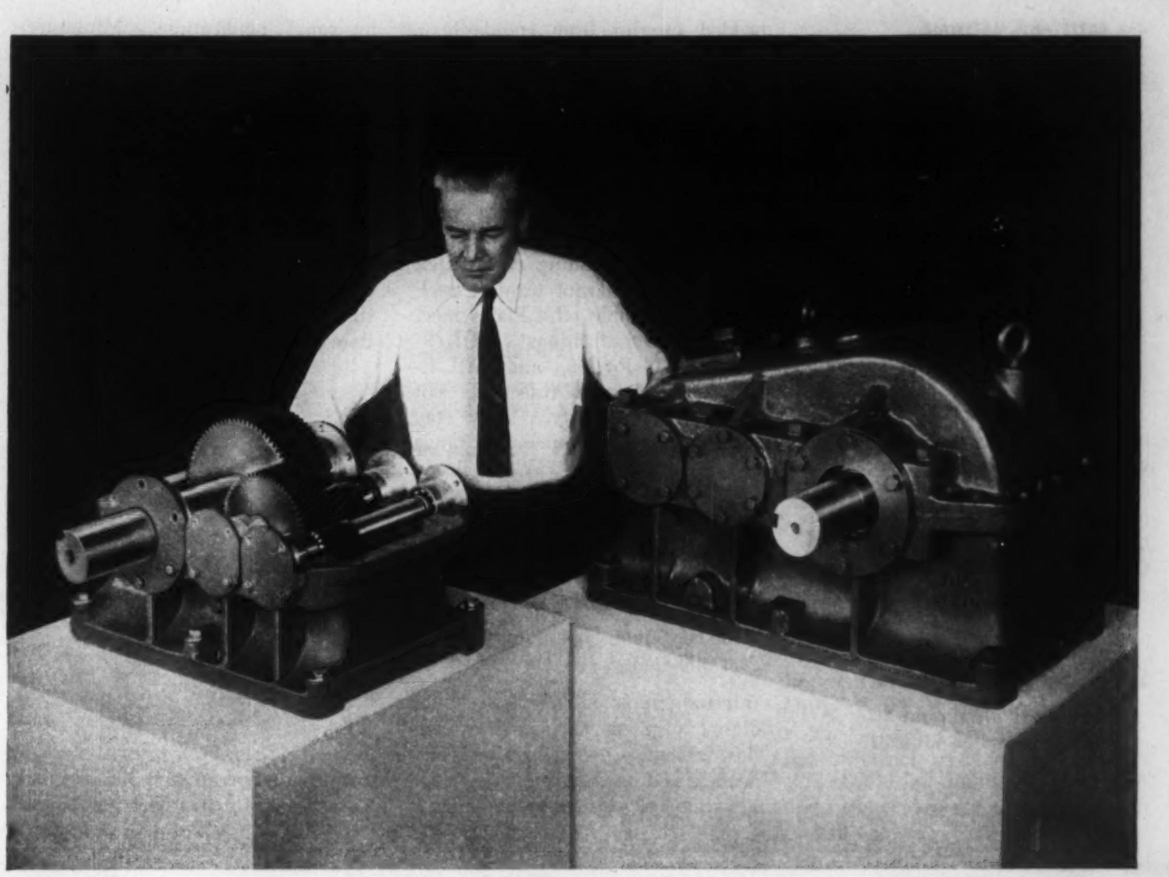


Circle 956 on Page 19

Automatic Relief Valves

for hot water tanks and heaters

Automatic temperature-pressure relief valves, designated Type NV, incorporate a thermostatic element which has no fluids to leak out and withstands high temperatures without deterioration. Valves automatically close tightly after relieving because of temperature or pressure increases. Having heavy cast-bronze



BOTH REDUCERS HAVE THE SAME CAPACITY!

This dramatic saving in weight and space is possible only because the reducer on the left has Philadelphia Precision Ground Gearing . . . a new development, so significant you can solve drive problems you could never solve before . . . because you get engineering advantages that have never been available before.

For the first time, standard commercial speed reducers are available with gearing of master gear quality. Extreme accuracy of profiles, profile spacing and surface finish reduce dynamic load factors. Harder gear materials can be used. Result: increased load carrying capacity without sacrificing performance characteristics.

Gear noise is reduced to the point where it is no longer a controlling factor in applications where low sound levels are important.

Backlash is reduced in reversing drives . . . and it is uniform where precision of movement is important.

Vibration is virtually eliminated because tooth to tooth errors, accumulated pitch errors and composite errors are reduced . . . smoother contact results.

Longer gear life. Improved accuracy and better surface finish eliminates "running-in" periods and the resulting wear on gearing.

If you have a new product on the boards . . . design changes coming up . . . or new drive requirements of any kind, Philadelphia Precision Gear Drives may give you the competitive edge you've been looking for. Write for full data on precision ground gearing in spiral bevel, parallel shaft and In-Line reducers as well as gearmotors and Motoreducers. If you have a special drive problem, the full facilities of our engineering staff are available to help you find the solution.

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Circle 607 on Page 19

bodies, valves are available with or without test levers, with or without 6-in. stems, and in ½ or ¾-in. male inlet connections. Relief settings range from 50 to 200 psi. Cash-Acme, P. O. Box 191, Decatur, Ill. I

Circle 957 on Page 19

Self-Bonding Nameplates

of anodized aluminum permit typewriter imprint

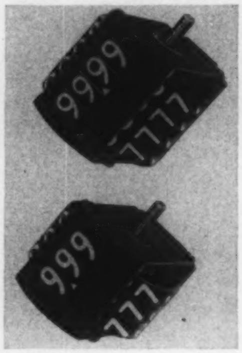
Anodized aluminum-foil 0.003-in. nameplates take a clean, sharp imbedded imprint from standard or electric typewriters. Self-bonding Quik-Plates are furnished in strip form, and adhere to metal, glass, plastic, and wood, on painted, smooth, flat, wrinkled, or curved surfaces. Plates are available in a wide range of colors with both glossy and matte finish. Colors and legends, including typewritten information, will not tarnish, peel, crack, or crumble off. Plates meet military specifications MIL-N-25076, MIL-P-6906, and MIL-E-5272A for abrasion resistance, salt spray, and humidity. They stay bonded through temperature range of −62 to +325 F. W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis. K

Circle 958 on Page 19

Miniature Counter

for continuous operation at 300 rpm

Internal-pinion counter is used for digital displays on airborne fuel-flow indicators, for navigational and dead-reckoning components, and for a variety of vertical-scale, indicating-panel applications. Miniature unit, Model 10322, provides indications from 0000 to 9999 with return to 0000 in one-unit increments. It can also be supplied optionally as a three-drum counter for three-digit indication. Counterclockwise rotation of right-hand shaft provides increasing readings. One revolution advances or reduces counter ten units. Unit is equipped with fixed shade and decimal point to facilitate reading. It is designed for continuous operation at 300 rpm and can be operated intermittently at



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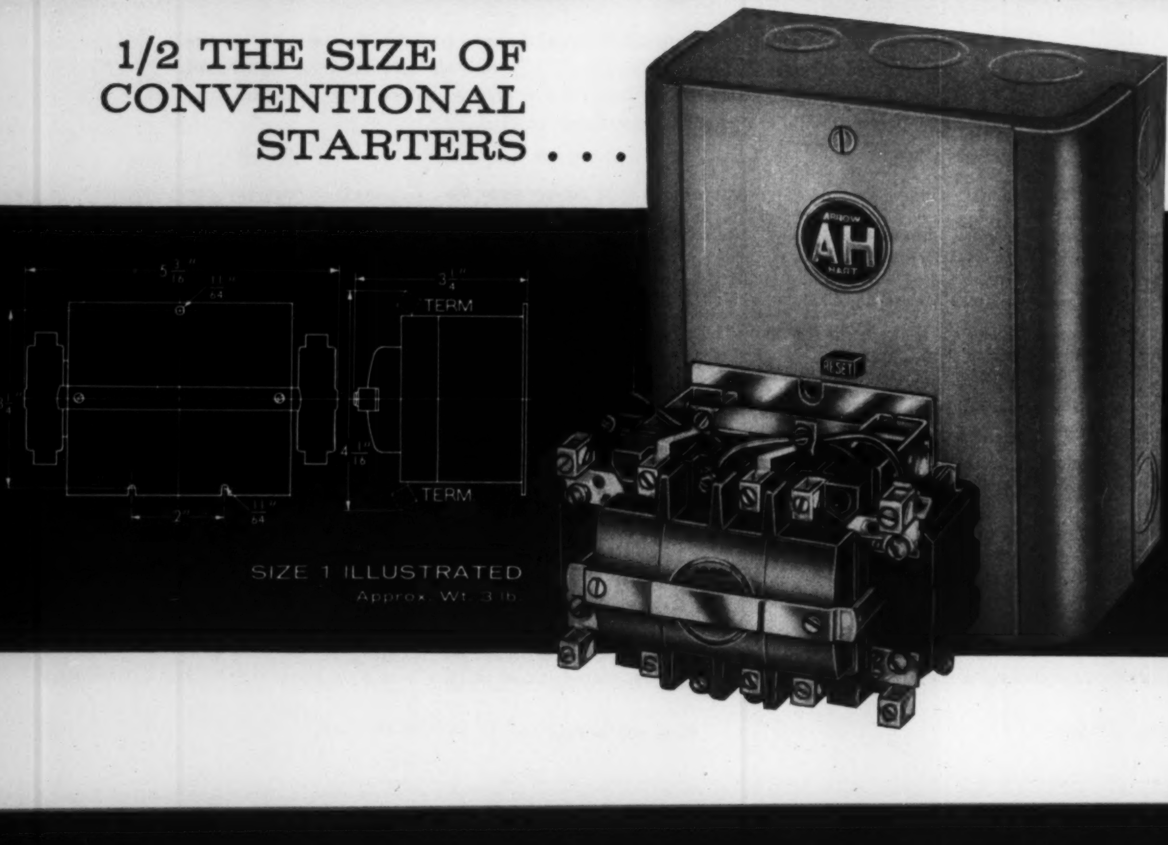
CONVENTIONAL
STARTERS . . .



SIZE 1 ILLUSTRATED
Approx. Wt. 3 lb

600 rpm. Counter can be operated in a −55 to +100-C temperature range, and conforms to requirements of MIL-E-5272A. **Bowmar Instrument Corp.,** 8000 Bluffton Rd., Ft. Wayne, Ind. J

Circle 959 on Page 19

Wire and Cable

are insulated with Teflon-FEP resin

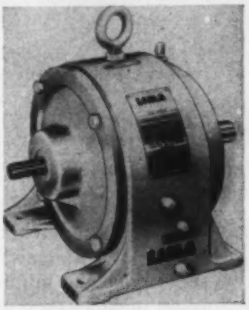
Designed for continuous service at 200 C, new wire and cable are insulated with Teflon-FEP fluorocarbon resin. Insulation permits use of tinned copper rather than silver-plated copper for conductors, and extra-long continuous lengths of insulated wire can be supplied. Fluorocarbon resin has excellent dielectric characteristics over a wide range of temperatures and frequencies. Toughness and other physical properties are outstanding at temperatures from −90 to +200 C. It is inert to nearly all chemicals, solvents, and fuels. Wire and cable insulated with the resin have good weather resistance, high resistance to ozone attack, are nonflammable, and have essentially zero water absorption. Good mechanical strength and abrasion resistance, even after high-temperature exposure, make wire and cable insulated with the resin suitable for aircraft, electronic, and industrial wiring. **Tensolite Insulated Wire Co. Inc.,** West Main Street, Tarrytown, N. Y. D

Circle 960 on Page 19

Speed Reducers

straight-line units have 5.06:1 to 1478:1 ratios

Foot-mounted, flange-mounted, or flange-mounted with extended housing, speed reducers are available with capacities of 0.077 to 147 hp and output speeds from 0.49 to 350 rpm. Straight-line units have 5.06:1 to 1478:1 ratios. Unit-case design assures permanent, accurate alignment of shafts, gears, bearings, and seals. Removal of endbell for inspection is accomplished quickly without disconnecting reducer from load. Bearings with extra capacity provide long, troublefree service under severe operating conditions. Cast housing dampens vibration and noise to provide quiet operation. **Lima Electric Motor Co. Inc.,** Dept. 139, Lima, Ohio. G



Circle 961 on Page 19

Rotary Tap Switch

has only 1-in. diam

Miniature rotary tap switch is a fully enclosed, concentric-shaft unit. Only 1 in. in diam, it permits two switches to be mounted in space normally occupied by one. Each shaft controls from one to three decks, with two to ten shorting or

MOTOR CONTROLS

THE *NEW MODEL* 58 "RA" STARTER

This new starter features the exclusive Arrow-Hart "Right Angle" mechanism with magnet operating through a simple bellcrank lever. The resulting mechanical advantage lets a much smaller, lighter magnet outperform older, direct-acting types. Control size and weight are reduced by half . . . performance and dependability are greatly improved.

New Model 58 Size 1 Starters offer:

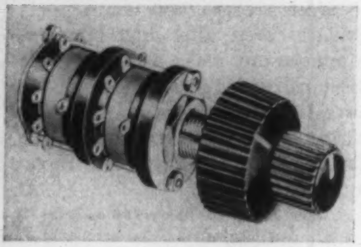
- **Wide Voltage Range Coils**
  Standard coil voltages are 110-120, 208-230, 440-480 and 550-600, at 60 cy.
- **Epoxy-Resin Encased Coils**
  Better protection against physical abuse, humidity, oil, fungus, shock, vibration, and other environmental conditions.
- **Wrap Around Enclosures**
  Make starters easier to install, wire, inspect and maintain.
- **Wiring Lugs**
  Make straight-thru front wiring easy.

Available in a complete line, NEMA Sizes 0 through 5, in Non-Reversing, Reversing Multi-Speed, Reduced Voltage Starters and others.

Write today for Motor Control Handy Reference Catalog No. 14 to The Arrow-Hart & Hegeman Electric Co., Dept. MD, 103 Hawthorn St., Hartford 6, Conn.

ARROW-HART of HARTFORD
Quality since 1890
MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES • WIRING DEVICES

Circle 608 on Page 19



nonshorting positions per deck. Unit is available as standard in over 6500 combinations of decks and positions. It is rated to break 1 amp, 115 v ac, or to carry 5 amp, with 3/8-32 threaded and keyed bushing. Switch is furnished with knobs and mounting nut. Grayhill Inc., 561 Hillgrove Ave., La Grange, Ill. I

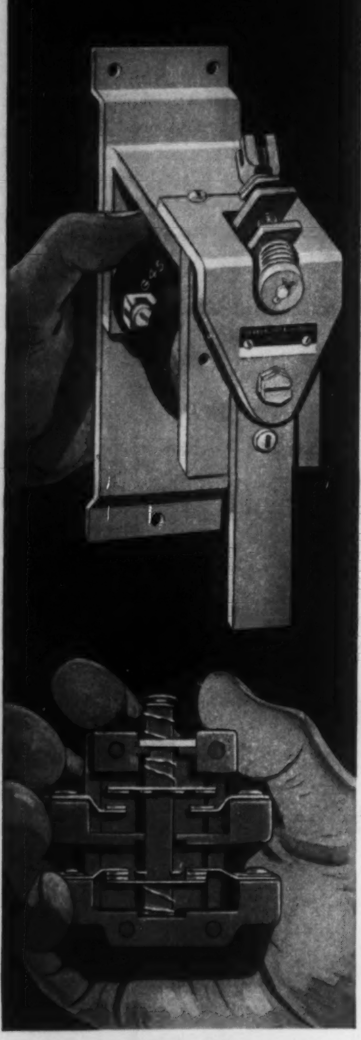
Circle 962 on Page 19

Centrifugal Clutches

provides no-slip service for small vehicles

Six models of packaged clutches, including pulleys, are designed for heavy, no-slip service and minimum maintenance on midget autos, scooters, golf carts, and riding mowers. Three models have 3-in. diam clutch and three have 3½-in. diam clutch. Engine or motor starts without a load and builds up to proper speed before clutch engages. Shaft sizes accommodated by the smaller diameter clutch are ½, ⅝, and ¾ in.; larger unit is designed for shaft diameters of ⅝, ¾, and 1 in. Pulley diameter is 3 in. except for model designed for 1-in. shaft, which takes 3½-in. pulley. Either diameter clutch engages at approximately 2000 rpm with springs provided. Other springs are available to enable clutch to be engaged at selected speeds from 1450 to 3100 rpm. Either an A or B belt can be used on any of the clutches in the line. Clutch can be used with almost all

DC CONTACTORS AND RELAYS



"BUILDING BLOCKS" CUT STOCKING COSTS

Reduce costly inventories—gain valuable storage space. Take advantage of General Electric's new "building-block" d-c contactors and relays and stock only a few standard parts. Desired devices can then be quickly and easily assembled when needed. Get complete details by following reader service instructions below. General Electric Company, Roanoke, Va.

784-20

Progress Is Our Most Important Product

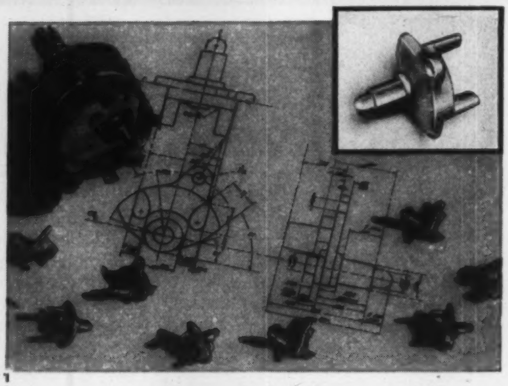
GENERAL ELECTRIC

Circle 609 on Page 19

"IMPOSSIBLE" PART

die cast for MALLORY by GRC

helped create higher rated, longer lasting switch



Quick deliveries on quantities of 100,000 to many millions.

NO SIZE TOO SMALL!

Max. weight ½ oz.
Max. length 1¾"

Write for detailed bulletin or send prints for quotation.

GRC
zinc
die
castings

"Impossible", yes, by *any other* method. BUT—GRC's unique single cavity die casting techniques made possible a detailed and complex actuating mechanism with exceptional requirements of uniformity and accuracy. Inspired Mallory engineers to design a new and better switch around this GRC die cast mechanism! Just another instance in which GRC's exclusive patented methods have solved a parts problem *and* opened the door to a new product . . . at substantial savings.

Be sure to see GRC at the Design Engineering Show—Booth 1524

GRIES

GRIES REPRODUCER CORP.

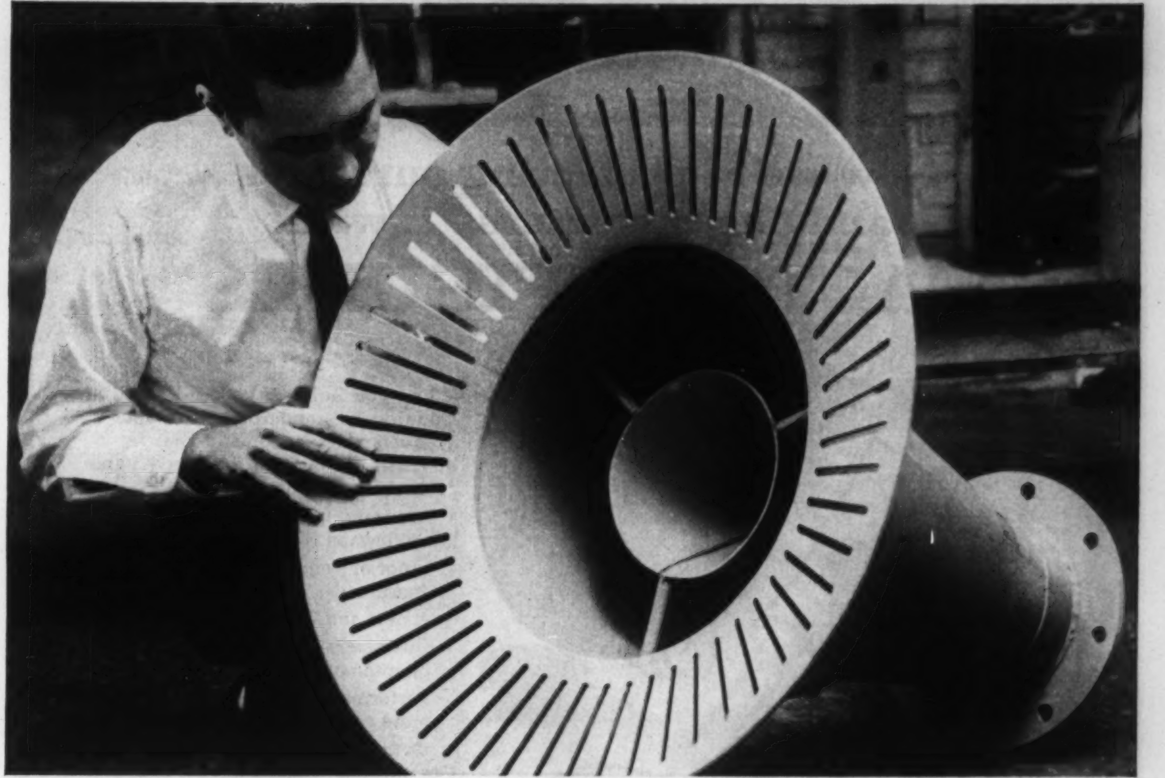
World's Foremost Producer of Small Die Castings

32 Second St., New Rochelle, New York • NEw Rochelle 3-8600

Circle 610 on Page 19

News about

B.F.Goodrich Chemical *raw materials*



Fume diffusers are fabricated by Electro-Chemical Products Company, Cleveland, Ohio, of sheets of rigid Geon made by Seiberling Rubber Company, Newcomerstown, Ohio. B.F.Goodrich Chemical Company supplies the Geon polyvinyl material only.

FUME DIFFUSERS TOOK A LICKING FROM CORROSION

. . . till the cones were made from GEON

THESE cones of Geon rigid vinyl show how you can solve corrosion problems. They are used to diffuse hydrofluoric and chromic acid fumes in a chemical plant, where cones of metal and other plastic were tried first.

Geon rigid vinyl solves corrosion problems—because it withstands acids, oils and many hydrocarbon chemicals. Geon also provides for accuracy in fabrication. For example, the sheet of rigid Geon from which these cones were made was machined to extremely close tolerance—.003 inches for the slots—to give the cones the exact design for most efficient fume dispersion.

Products of versatile Geon polyvinyl materials can be made in rigid form, rotationally cast, slush molded, calendered, extruded or blown into foam form. Applications range from solving all types of corrosion problems from piping to ductwork, to coatings for paper, metal and other materials.

For information on Geon polyvinyl raw materials, write Dept. AS-2, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

A TRADE MARK OF B.F.GOODRICH CHEMICAL COMPANY

Geon

Polyvinyl Materials

A DIVISION OF THE B.F.GOODRICH COMPANY

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GEON polyvinyl materials • HYCAR rubber and latex

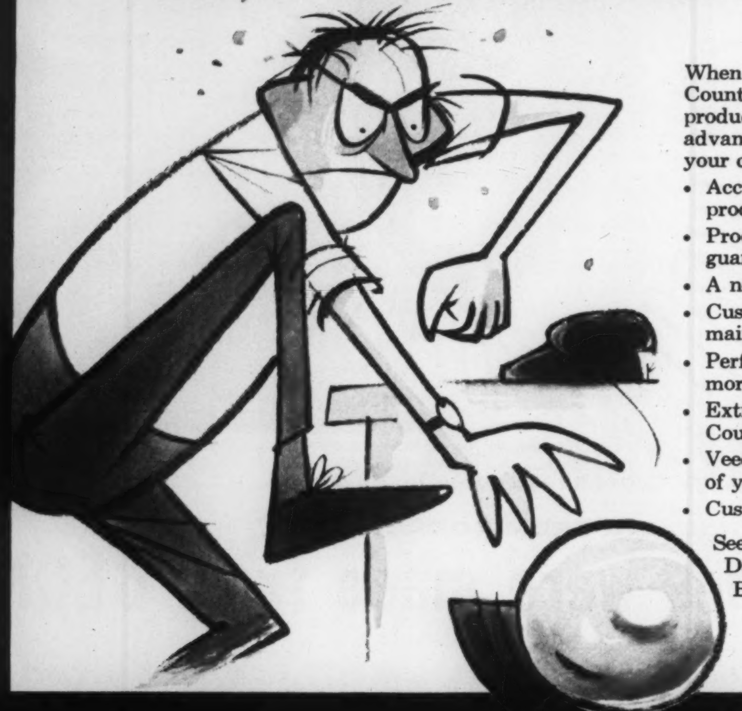
GOOD-RITE chemicals and plasticizers • HARMON colors

Circle 611 on Page 19

"No More Crystal Ball!

Now we're protecting ourselves . . . and our customers . . . with

FACTS-IN-FIGURES"

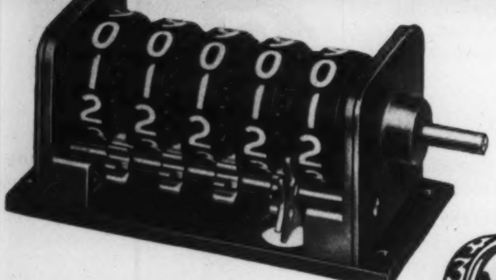


When you build-in Veeder-Root Counters as standard parts of your product, here are some of the advantages you gain for yourself and your customers:

- Accurate, up-to-the-minute production records
- Proof of your product's service guarantee
- A new and powerful selling feature
- Customers can see when maintenance is due
- Performance claims are settled more easily
- Extra profits in resale of VR Counters
- Veeder-Root name is added evidence of your product's top quality.
- Customers are freed from guesswork

See Veeder-Root Counters at the Design Engineering Show Booth 1529

You always "Know the score" when you count on Veeder-Root!



#1370 High Speed Counters are rated at 1500 rpm . . . will accept momentary speeds up to 2500 rpm. 3, 4, 5 or 6 figures. Non-reset. *Send for new Condensed Catalog.*

Everyone can Count on VR® **Veeder-Root Inc.**

Hartford 2, Connecticut

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

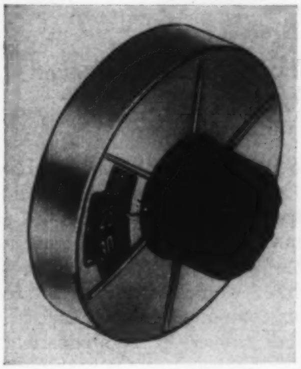
popular makes of small gasoline engines, and can also be used with electric motors rated from 1 to 3 hp. **Magneto Div., Fairbanks, Morse & Co.,** Beloit, Wis. K

Circle 963 on Page 19

Turns-Counting Dial

of lightweight plastic has no backlash

VerniDial Model H5850 fits shafts of potentiometers, capacitors, valves, and other equipment where micrometer readout of setting is required. Lightweight plastic dial consists of two coaxial dials. Inner dial is graduated in hundredths of a turn, and outer dial accumulates number of completed turns up to 20. Rotation of inner dial through a Geneva movement indexes outer dial at completion of each turn. Operating knob, integral with inner dial, is directly connected to shaft of device being positioned. There is no backlash. **Howell Instrument Co.,** 3101 Trinity St., Ft. Worth 7, Tex. P



Circle 964 on Page 19

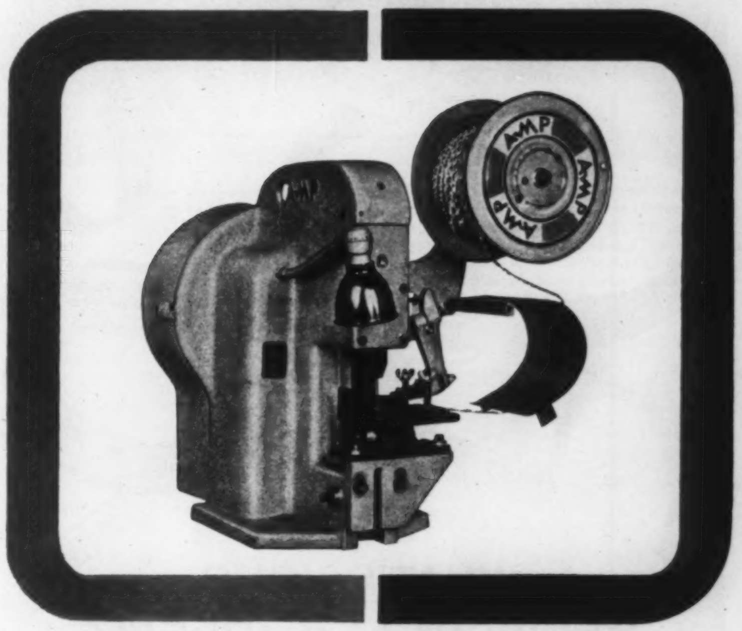
Check Valve

in six sizes from ½ to 2 in.

Redesigned with fewer parts, bronze swing check valve of heavy-duty construction is recommended for industrial applications of steam, water, oil, and gas service where backflow must be prevented. Generally used in conjunction with a gate valve, it can be installed in either a horizontal or vertical position. Easy access is provided to bronze

FASTER

THAN YOU CAN SAY "CIRCUIT TERMINATION BY A-MP"



Speed—amazing speed—is fundamental with AMP's tool-and-terminal technique. In fact, an A-MP automachine can turn out 4,000 terminations per hour.

No extensive operator training is required. And, no large floor space—the bench-mounted Automachine takes up less space than an ordinary desk. It's built for safety, built for speed, built for reliable production day after day. And A-MP Automachine terminals are made in a size and shape to fit every requirement with such features as corrosion resistance, vibration resistance, and, if required, pre-insulation. Furthermore, actual costs of the AMP method are lower than any other method.

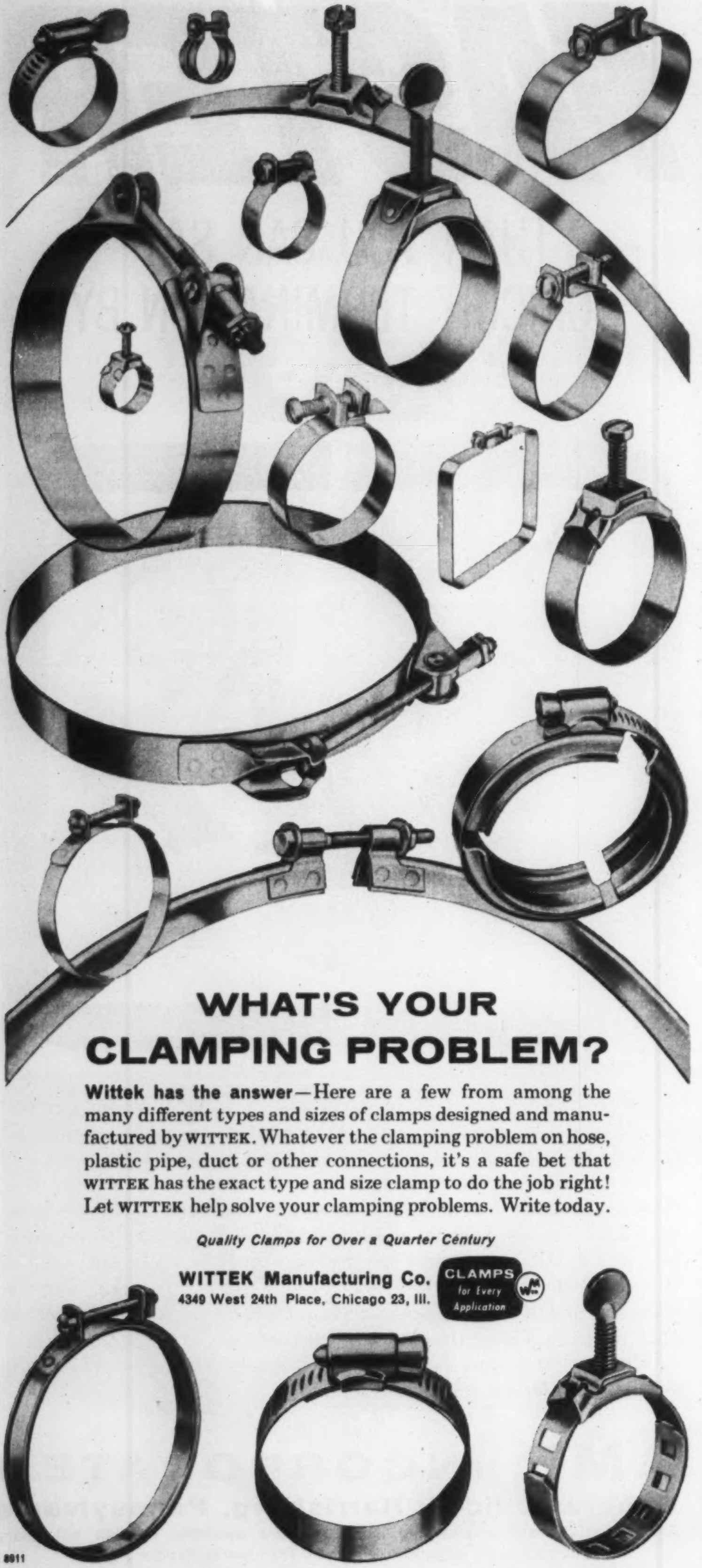
Why not learn more about this world famous compression-attachment method? Send for our descriptive literature.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

Circle 613 on Page 19



WHAT'S YOUR CLAMPING PROBLEM?

Wittek has the answer—Here are a few from among the many different types and sizes of clamps designed and manufactured by WITTEK. Whatever the clamping problem on hose, plastic pipe, duct or other connections, it's a safe bet that WITTEK has the exact type and size clamp to do the job right! Let WITTEK help solve your clamping problems. Write today.

Quality Clamps for Over a Quarter Century

WITTEK Manufacturing Co.
4349 West 24th Place, Chicago 23, Ill.

CLAMPS for Every Application

8911

Circle 614 on Page 19

disc for regrinding, which is accomplished without removal from line. Disc is attached to a freely swinging hinge. Pressure in one direction swings disc clear of seat, and pressure in opposite direction forces it onto its seat. Valve, available in six sizes from ½ to 2 in., is rated for 125 psi saturated steam and 200 psi oil, water, and gas. **American Chain & Cable Co. Inc.,** 929 Connecticut Ave., Bridgeport 2, Conn. B

Circle 965 on Page 19

Silicone Rubber Compound

is available in a variety of colors

To eliminate identification problems encountered with potted and encapsulated materials, PA-407 silicone rubber compound is now available in a variety of colors, plus white. A quick-setting, shrink-resistant compound, it sets up to become rubber in approximately 25 min. Supplied in pourable liquid state, compound is suitable for either dipping or knife coating. It has excellent water repellency, provides protection from corrosive atmospheres, salt water, and dilute acids and alkalies, and maintains high insulation resistance and dielectric strength in the presence of humid conditions. **Plastic Associates,** 185 Mountain Rd., Laguna Beach, Calif. L

Circle 966 on Page 19

Nylon Snap Bushing

for use in ⅞-in. diam chassis hole

Available with various inside IDs, nylon snap bushing requires no tools to install. It snaps into a ⅞-in. diam chassis hole and locks under finger pressure. No threaded holes or nuts are required to hold it in place. It cannot be removed unless

You can solve many problems **better**
and at **lower cost** with DIAMOND Roller Chain

Complex Automated
Equipment for Post Office
Department is
Synchronized by
DIAMOND
Roller Chain

Five parallel strands of DIAMOND Roller Chain feed code-marked letters to an electronic decoder which presets the "memory wheel" codes attached to letter baskets. Letters are automatically fed to the baskets by a second DIAMOND-equipped conveyor.

The main conveyor consisting of partitioned baskets suspended between parallel strands of DIAMOND Conveyor Chain, passes over rows of "destination" bins and deposits each letter in its appropriate bin in response to the preset arrangement of the "memory wheels."

● Labor-saving equipment developed for the Post Office Department by the Rabinow Engineering Company, Washington, D. C., uses DIAMOND Roller Chain exclusively for power transmission, conveying and to synchronize the machine's multiple operations.

The smooth coordination of the several functions performed by this one machine demonstrates the adaptability of DIAMOND Roller Chain to a wide range of power-and-motion transfer problems. The equipment's efficiency and operating economy testify to DIAMOND's accuracy, its durability and dependable, trouble-free service.

DIAMOND engineers will be glad to help you work out roller chain drives that will result in better design, better performance and lower operating costs for *your* product.

DIAMOND publishes a complete library of roller chain information for design engineers . . . available upon request, without obligation. Write for your copies today.

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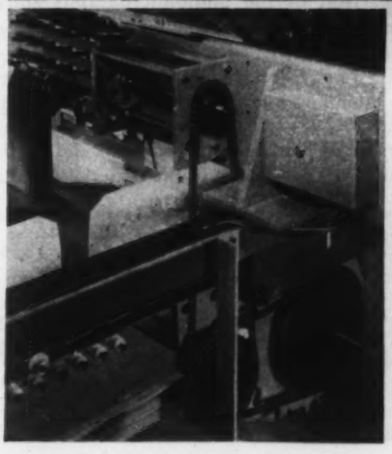
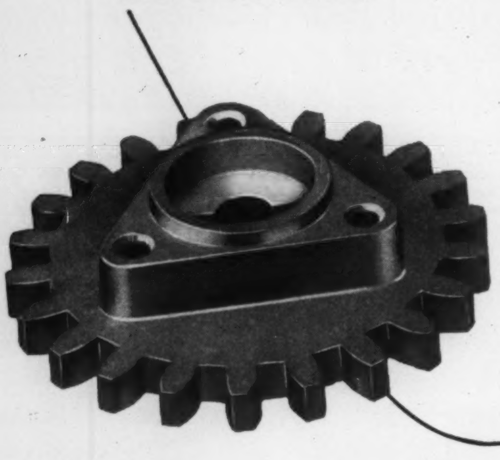
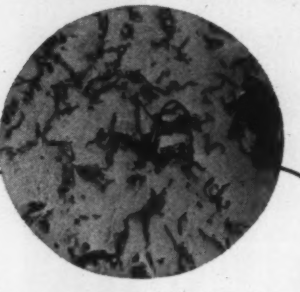
DIAMOND ROLLER CHAINS



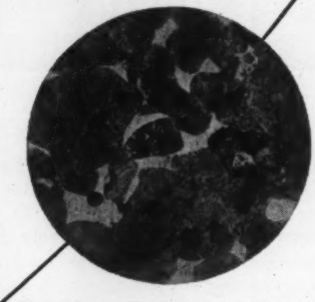
Single Strand DIAMOND Roller Chains synchronize the many conveying, timing and selective movements required to sort mail rapidly and accurately in Rabinow's automated equipment.

Quality of GRAMIX® precision parts insured by metallurgical control in the laboratory *proven by performance on the job!*





Photomicrograph of a section of an inferior powder metallurgy part that has been improperly sintered. Structure is composed of cementite and ferrite.



Photomicrograph of an internally sound GRAMIX part shows the fine grain structure of tough, shock-resistant pearlite.

To assure the dependable performance of GRAMIX powder metallurgy parts in actual operation, the United States Graphite Company combines exacting laboratory tests and rigid production controls to insure the quality of every GRAMIX part. Through the use of the metallograph, for example, GRAMIX engineers can check the internal structure of a part. A comparison of the photomicrographs shown above readily shows the sound under-the-surface quality of a GRAMIX part as opposed to the poor internal composition of an improperly sintered part. In the photomicrograph at the top, notice the cementite between the ferrite grain boundaries. This cementite will tend to break up and rupture under shock. The surface of the material is decarburized and only remnants of pearlite remain. *This condition is due entirely to the lack of adequate sintering control!*

The photomicrograph of the GRAMIX part at the bottom shows a fine grain pearlite structure that's tough, strong and wear resisting. Absolute sintering control along with precise metallurgical control in the laboratory is utilized by The United States Graphite Company to positively assure quality GRAMIX parts.

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

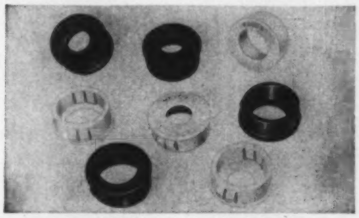
X-264-1R

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Circle 616 on Page 19



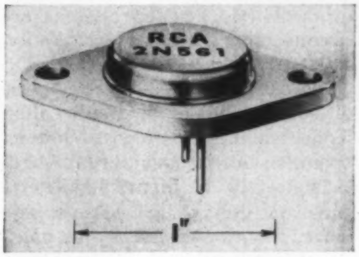
nylon step-clips are compressed. Wire, cable, hoses, or tubing can be run through bushing which provides a neat appearing and smooth, unbreakable insulation protection. Unit can be locked into panels of varying thickness to 1/8 in. **Heyman Mfg. Co.**, 1200 Michigan Ave., Kenilworth, N. J. D

Circle 967 on Page 19

Power Transistors

for heavy-duty applications

Two high-voltage, high-current power transistors, designated 2N561 (shown) and 2N1014, are for use in heavy-duty industrial and military applications. Alloy-junction transistors of germanium p-n-p type, they feature maximum peak-collector current rating of −10 amp. Design utilizes a mount structure in which collector is electrically and thermally connected to mounting flange. Mounting arrangement provides for good electrical contact and excellent transfer of heat from transistor junctions to heat sink. **Semiconductor Div., Radio Corp. of America**, Somerville, N. J. D



Circle 968 on Page 19

Impulse Switch

controls solenoid valves and starter relays

One-way impulse switch is particularly useful for air-cylinder and hydraulic applications where impulse action is required. It provides simplified electrical control for sole-

HOW WOOD'S TIMING BELT DRIVES GIVE A PRECISE CASE OF "SHAKES" TO OVER A TON OF DEAD WEIGHT

Remarkably fast Lorco Vibrators precision finish a wide range of metal and plastic parts in as little as 1/100th the time required by conventional tumbling barrels. Drastic main drive requirements call for highly accurate maintenance of vibratory frequencies and ability to withstand severe shock loads imposed by heavy chips and parts weighing as much as 1½ tons per load.

The slip-free, positive action and absence of belt stretch in Wood's Timing Belt Drives fills these needs month-in and month-out in 'round-the-clock service. These compact drives not only satisfy the ruggedness and high efficiency requirements of this application, but have long life and eliminate maintenance and matching of belts. Having no metal-to-metal contact, they require no lubrication. These features permit the use of this drive in cramped, relatively inaccessible areas.

Wood's Timing Belt Drives have a wide range of load capacities, up to 600 hp and above, and cover an exceptional speed range, from zero to 16,000 fpm. They offer outstanding solutions to a wide variety of drive problems.

V-BELT DRIVES • VARIABLE SPEED DRIVES • TIMING BELT DRIVES • CARD DRIVES • FLEXIBLE AND RIGID COUPLINGS • FLYWHEELS • PULLEYS • MOTOR BASES • BALL BEARING PILLOW BLOCKS, FLANGE UNITS AND TAKE-UP BEARINGS • BABBITTED AND BRONZE BEARINGS • DUCTILE IRON PRODUCTS

For complete information and your copy of Catalog 2100, contact your T. B. Wood's distributor.

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T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA

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Circle 617 on Page 19

WHY

YOU GET MORE WHEN YOU BUY VIKING ROTARY PUMPS

COMPLETE SELECTION

In many cases, you can quickly order the pump you need. Why? Because you can select from over 750 catalogued models and thousands of specials . . . in sizes from 2/3 to 1050 gallons per minute. You can save time and money buying from this one **complete** source!

TOP QUALITY

Every Viking Pump has quality built into it — quality that will save you many repair bills. Ask the service man how **he** rates Viking. You will find they have top rating.

ROTARY PUMP "KNOW HOW"

Engineers at Viking apply and think rotary pumps and **nothing** but rotary pumps. From them, you can get the best information on rotary pump applications . . . no half-way measures at Viking.

Send today for our 8-page folder on Viking Pumps . . . series 59SH.

VIKING PUMP COMPANY

Cedar Falls, Iowa, U. S. A. In Canada, it's "ROTO-KING" pumps

See Viking Pump Booth No. 1610,
Design Engineer's Show,
Convention Hall, Philadelphia, May 25-28

Circle 618 on Page 19

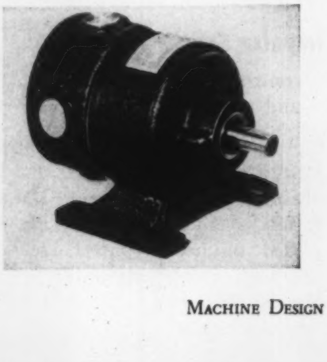
noid valves and starter relays by eliminating need for one-way actuators, interlocks, or delay devices. Basic switch is a Licon Type 10, high-capacity unit which provides long life and excellent repeatability. Switch is rated for 15 amp, 125/250/460 v ac; 15 amp resistive, 5 amp inductive, 5 amp motor, 30 v dc. **Licon Switch Div., Illinois Tool Works,** 2501 N. Keeler Ave., Chicago 39, Ill. J

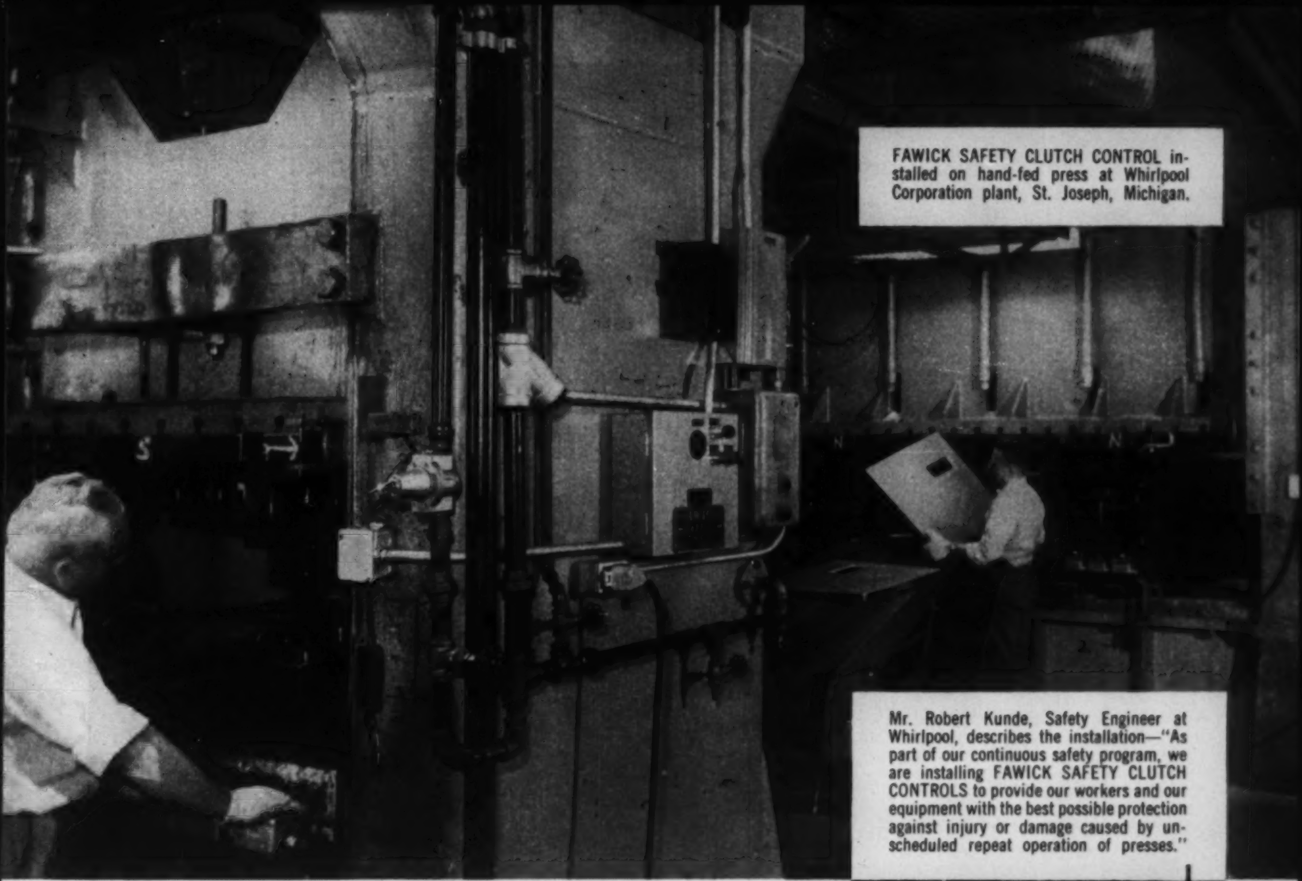
Circle 969 on Page 19

Zero Speed Switches

can be driven at speeds through 3800 rpm

Series 2100 Dazic switches are shaft-driven electrical units with magnetically actuated contacts operated by a hydraulically driven mechanism. They open or close signal circuits on shaft-speed acceleration as low as 15 rpm and can be driven at speeds through 3800 rpm. Use of silicone oil as hydraulic fluid lends stability to repeat contract operation over temperature range of −20 to +250 F. Models have hardened and ground ½-in. shafts, supported by two spaced ½-in. precision ball bearings. Required driving torque is approximately 4 oz-in., and units can be mounted for operation in any position. Electrical contacts are totally enclosed, SPDT snap-action types, and carry ratings





FAWICK SAFETY CLUTCH CONTROL installed on hand-fed press at Whirlpool Corporation plant, St. Joseph, Michigan.

Mr. Robert Kunde, Safety Engineer at Whirlpool, describes the installation—"As part of our continuous safety program, we are installing FAWICK SAFETY CLUTCH CONTROLS to provide our workers and our equipment with the best possible protection against injury or damage caused by unscheduled repeat operation of presses."

another Fawick First!

. . . the new "fail-safe" press and automation control

Press owners and operators alike are very enthusiastic about the new FAWICK Safety Clutch Controls (Andrus-Coon System). This outstanding development prevents "unscheduled" repeats in press operation, with a "fail-safe" system that eliminates possibility of component operation failure.

The FAWICK Safety Control utilizes a dual system, with two completely independent sets of controls and all systems and circuits so established, either before or during the operating cycle, that two complete and separate control systems are functioning at the time the "automatic stop" (at the top of the stroke) is required. The mathematical law of probability of simultaneous failure of two similar (or even dissimilar) devices in this system has been calculated conservatively at one (1) in 110,000,000,000 cycles. This great safety advancement is available for installation on new equipment or that being re-newed or overhauled.

For complete details on the FAWICK Safety Clutch Control call or write your nearest FAWICK representative or the Home Office, Cleveland, Ohio.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK
AIRFLEX
INDUSTRIAL CLUTCHES AND BRAKES

Circle 619 on Page 19

Mission: **MAN IN SPACE**
Filter Application: **PROTECT HYDRAULIC CONTROLS**
Filter: **PUROLATOR**

A malfunction in the lines of the hydraulic and pneumatic controls of the X-15 could send it off its programmed trajectory . . . alter the angle of re-entry . . . cause deviation from the ballistic arc.

Purolator filters are on the X-15 to protect the control systems. Three new filtering applications were worked out for North American Aviation, designers and builders of the X-15, by Purolator engineers to meet the space-age requirements of the manned missile.

Filters for crucial aircraft and missile requirements are a specialty at Purolator . . . and every application is considered as crucial as those on the X-15. Draw on Purolator's experience to help you handle your filtration requirements. A phone call or a descriptive letter, with plans or blueprints, will receive prompt attention.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada

Circle 620 on Page 19

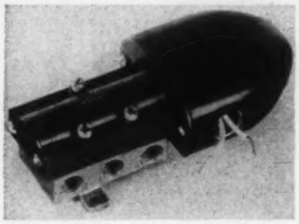
of 10 amp at 125/250 or 460-v ac, ½ amp at 125 v dc, and ¼ amp at 250 v dc. **Winterburn Mfg. Co.**, Putnam, Ky. B

Circle 970 on Page 19

Four-Way Valve

has standard sub-base mounting

Model A ¼-in. valve is rated at 200 psi or vacuum air service. The four-way unit features sub-base mounting as standard. Body and spool have packless features, with precision tolerances of 0.00005 in. to provide consistent sealing characteristics. All working surfaces are provided with a hardness equivalent to that of tungsten carbide. All ports are unrestricted full pipe area passages, resulting in high flow capacity. Valve is available with a variety of actuations, including hand, foot, pilot, cam, solenoid, or bleeder type. **Alkon Products Corp.**, 200 Central Ave., Hawthorne, N. J. D

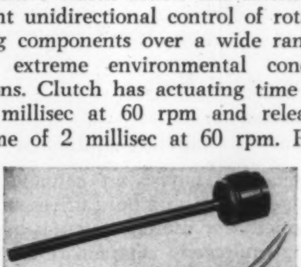


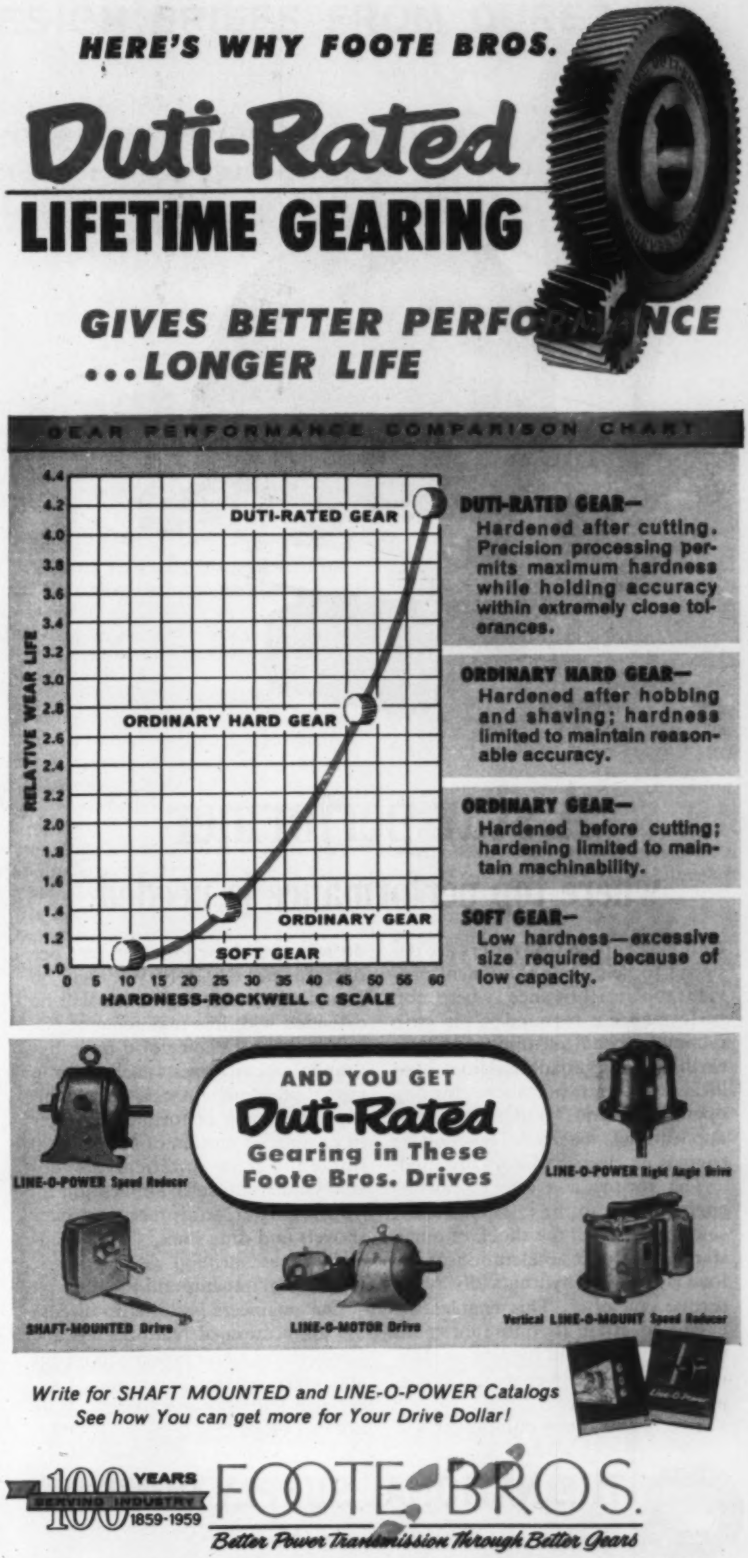
Circle 971 on Page 19

Clutch and Actuator

for rotating components

Primarily designed for airborne equipment, Model CK-1 friction-type clutch and actuator provide positive clutch action and intermittent unidirectional control of rotating components over a wide range of extreme environmental conditions. Clutch has actuating time of 3 millisec at 60 rpm and release time of 2 millisec at 60 rpm. For





HERE'S WHY FOOTE BROS.
Duti-Rated
LIFETIME GEARING
GIVES BETTER PERFORMANCE
...LONGER LIFE

GEAR PERFORMANCE COMPARISON CHART

RELATIVE WEAR LIFE
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
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1.4
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5
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15
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25
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35
40
45
50
55
60
HARDNESS-ROCKWELL C SCALE
DUTI-RATED GEAR
ORDINARY HARD GEAR
ORDINARY GEAR
SOFT GEAR

DUTI-RATED GEAR— Hardened after cutting. Precision processing permits maximum hardness while holding accuracy within extremely close tolerances.

ORDINARY HARD GEAR— Hardened after hobbing and shaving; hardness limited to maintain reasonable accuracy.

ORDINARY GEAR— Hardened before cutting; hardening limited to maintain machinability.

SOFT GEAR— Low hardness—excessive size required because of low capacity.

AND YOU GET Duti-Rated Gearing in These Foote Bros. Drives

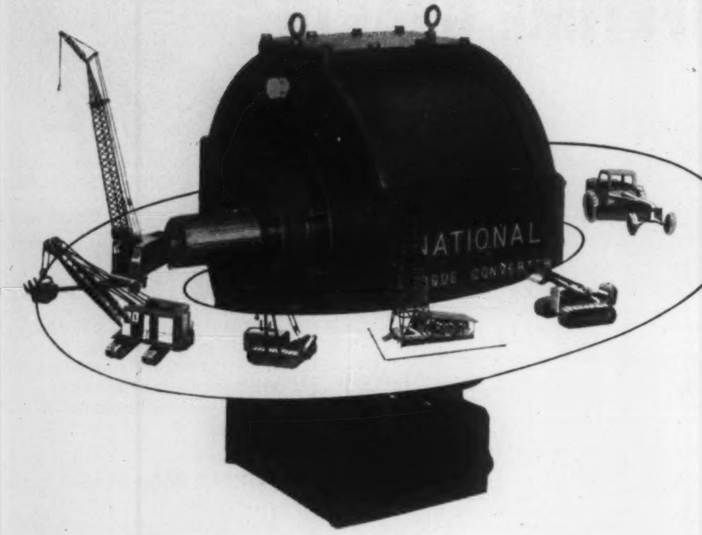
LINE-O-POWER Speed Reducer
LINE-O-POWER Right Angle Drive
SHAFT-MOUNTED Drive
LINE-O-MOTOR Drive
Vertical LINE-O-MOUNT Speed Reducer

Write for SHAFT MOUNTED and LINE-O-POWER Catalogs
See how You can get more for Your Drive Dollar!

100 YEARS SERVING INDUSTRY 1859-1959
FOOTE BROS.
Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4567 SOUTH WESTERN BOULEVARD • CHICAGO 9, ILLINOIS

Circle 621 on Page 19



A star performer

where top performance is needed

National Torque Converters are designed to help your equipment provide top performance where top performance is required . . . in strip mining, mechanized mining, drilling, earth moving, road building, load lifting and transportation, logging operations, and similar industrial applications...wherever Diesel or gas engines or electric motors are used.

The torque converter transmits engine power to the job in a steady, smooth flow. All the shock of quick starting and fast acceleration of the load is absorbed hydraulically by the torque converter. This enables the engine to attain its optimum speed quickly . . . without lugging or stalling . . . and to deliver its full horsepower constantly.

The result: Your equipment will do more work or jobs per unit per operator per day, job cycles will be completed faster, engine life will be extended with less maintenance.

You have a choice of 6 basic hydraulic circuit sizes, each with a range of input ratings, to permit exact matching of torque converter to engines or motors of 100 to 1000 horsepower in practically every heavy-duty industrial application . . . on all power equipment—power shovels and drag lines, shovel loaders, cranes, drilling rigs, graders, logging equipment, and the like.

Our engineers will gladly discuss the application of National Torque Converters to your power equipment and make recommendations of exact size and torque capacity. Why not call on us?

THE NATIONAL SUPPLY COMPANY

Subsidiary of Armco Steel Corporation

TWO GATEWAY CENTER, PITTSBURGH 22, PENNSYLVANIA

Circle 622 on Page 19

use with a $\frac{1}{4}$-in. shaft, clutch transmits a torque load of 120 oz-in. continuous duty. Positioning of single or multiple actuator stops on clutch makes possible one revolution or angular portion of one revolution with high accuracy indexing. Clutch and actuator operate under temperature range of −65 to +300 F. Total weight of assembly is 4 oz. **Abrams Instrument Corp.**, 606 E. Shiawassee St., Lansing 1, Mich. H

Circle 972 on Page 19

Control Valve

incorporates color coding of valve setting

COLORFLOW CONTROL

Colorflow valve is available in flow control, needle, and check types, in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$-in. sizes. Design incorporates coding system for valve setting, using color and numbers. Reading can be readily interpreted. Colorflow system permits knowledge at all times of what portion of complete range of valve is being used. Valve materials are brass, steel, or stainless, with aluminum available on special order. For air, oil, or water service, valve is rated at 2000 psi in brass and 5000 psi in steel and stainless. **Manatrol Co.**, 2108 Payne Ave., Cleveland 14, Ohio. F

Circle 973 on Page 19

Crane-Hoist Motors

for use in materials-handling equipment

Crane-Hoist motors are suitable as bridge, trolley, and hoist drives, and especially for use on materials-handling equipment. Special windings, built into squirrel-cage, multispeed, fluid-shaft, and slip-ring, wound-rotor motors, provide high-slip, high-torque characteristics. Mount-

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Fire-retardant electrical laminates**
- **Plastic for wire-spring relay**

Plain . . .

or fancy

This electrical laminate deserves more than a casual look, if only because there are so many things you can do with it.

Made of glass-reinforced polyester, it comes in sheets or molded shapes that embody three useful attributes. First, they are strong enough to play a structural role in heavy-duty electrical equipment. Second, they retard fire. Third, their excellent electrical properties change but little at 100% relative humidity.

The shapes you see here are made with Hetron® polyester resin by Fiber Glass Industries, Inc., and are inherently flame-retardant. Hetron burns only in the immediate vicinity of an arc or hot flame, and quickly extinguishes itself when the heat source is removed. Thus in case of a burnout, damage is usually confined to a small area, with minimum effect on mechanical strength of the material.

Generally, Hetron laminates exhibit very low loss factor over a wide range of frequencies. Dielectric constant, for a ⅛-inch glass-mat laminate containing 35% glass, hovers as low as 4.25. Arc resistance of such a laminate is on the order of 110 seconds.

Do these traits suggest a way to achieve long life in equipment handling medium and high voltages? We'll gladly send you the complete data file on Hetron resins, and names of skilled fabricators who can supply laminates and molded shapes to match your ideas.

Building a better relay

Often it isn't enough to design a product. You may also have to find a way to make it.

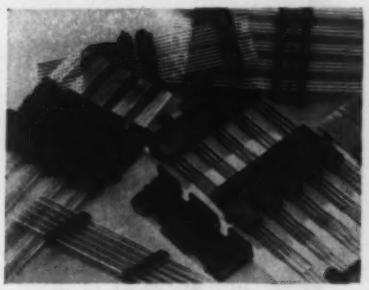
Such was the case when engineers at Bell Telephone Laboratories developed for Western Electric Co. a new relay, basic component of telephone switching equipment.

In one swoop the new design—called the wire-spring relay—promised to reduce manufacturing and maintenance costs, work better, and last longer than its predecessor. However, this involved something that had never been done—molding straight wires into small plastic blocks automatically.

Before it could be done, Western Electric engineers had to:

1. devise a way to straighten small-diameter spooled wire;
2. feed the straightened wire into a mold in precisely spaced groupings;
3. embed the wires without shift in a molding compound that would insulate them and hold them securely for a relay lifetime of one billion operations or more.

Early in the game it became apparent that this was a job for phenolics. A major requirement was fast cure. Another was batch-to-batch consistency of the molding material. At fast cure speeds, a 10% variation in curing time can mean as little as 1.2 seconds' leeway between a reject and a good piece.



Volume resistivity was important. Could a Durez material handle the job?

Yes, one could. The wire-spring subassemblies you see here are made with it. They are being produced at low cost to the required accuracy in fully automatic molding machines. They prove the ingenuity of the men who developed this new concept in telephone switching—and the versatility that *you* command when you design with Durez materials.

To get a better idea of how far this versatility goes, check the coupon for more information. Booklets are available describing a range of properties you can get from typical Durez materials; give helpful suggestions on where to use them.

For more information on Durez materials mentioned above, check here:

☐ Data on Hetron, including fabricator lists (50-A)
☐ Durez molding compounds (14 page booklet)
☐ General information on Durez Products (Bulletin 400)

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ PLASTICS DIVISION
5 0 5 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER
CHEMICALS
PLASTICS

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MIDLAND

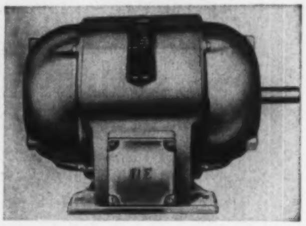
WELDING NUTS for those hard-to-reach spots!

On the lookout for ways to cut costs and save time? Write for free booklet, "Save With Midland Welding Nuts."

M-R MIDLAND-ROSS CORPORATION
OWOSSO DIVISION • OWOSSO, MICHIGAN

MIDLAND WELD NUT

Circle 624 on Page 19



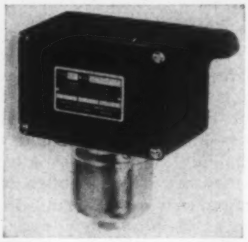
ing adaptations, through use of flanges, rings, and feet, are possible. Motors are available in ratings from ½ through 50 hp, in frame sizes 182 through 365U, and in dripproof or totally enclosed, 15 or 30-min duty ratings. All units have lightweight, cast - aluminum frames. **Reuland Electric Co.**, 3001 W. Mission Rd., Alhambra, Calif. L

Circle 974 on Page 19

Pressure Control

for uses requiring close on-off differentials

Waterproof pressure-vacuum control, Type J6, Model 200 Series, is designed for air, gas, or liquid applications requiring close on-off differentials. Adjustable ranges are from 30 in. Hg vacuum to 300 psi with differentials from 1.5 ± ½ in. Hg to 4 ± 1 psi. Control is uncalibrated, and pressure settings are made by removing cover and adjusting hexhead adjustment screw. Enclosure is die-cast aluminum with black wrinkle finish. Many types of switches are available. **United Electric Controls Co.**, 79 School St., Watertown 72, Mass. B



Circle 975 on Page 19

Controlled Rectifiers

50-amp units are available in development quantities

High-current, silicon-controlled rectifiers act as both power transistors and rectifiers. They change alternating to direct current, and control amount of current fed into a circuit. Units are designed for use in the electric power distribution systems of missiles, aircraft, submarines, and other military equipment. Other applications include television studio and theater lighting controls, adjustable-speed drives for dc motors, and motor and generator field excitation. Developmental samples have peak inverse voltage ratings of 25, 50, 75, 100, 150, and 200 v. They handle 50-amp at 125 C stud temperature in a single-phase circuit. Units are only 2 in. high, 1 in. in diam, and weigh 3 oz. **Semiconductor Products Dept., General Electric Co.,** Syracuse, N. Y. N

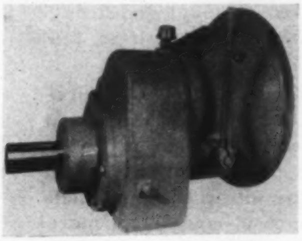
SEMICONDUCTOR

Circle 976 on Page 19

Reduction Gear

heavy-duty unit has input torque of 650 lb-ft

For use in construction, mining, and industrial fields, heavy-duty reduction gear has transmission ratios from 1.43:1 to 2:1 for either engine or antiengine rotation. Maximum input torque is 650 lb-ft with maximum input speed permissible to 2200 rpm. Transmission permits high-speed diesel engines to be operated at their most efficient speed. Model SR-700 is furnished for attachment directly to engine, and is available with SAE No. 1 bell housing. Disconnect clutch and pilot bearing are provided to meet engine specifications. Standard out-



(*Please turn to Page* 332)

ONE PART REPLACES FIVE!

BY POWDER METALLURGY

Tremendous savings and performance advantages resulted when Dixon Sintaloy Engineers, in collaboration with the Briggs & Stratton Corporation, redesigned this five-piece cam and ratchet as a single powder metallurgy part. Excellent bearing qualities plus self-lubrication of the Sintaloy iron-copper part eliminated the need for the bronze bearing insert and thrust washer. The cam is now integrally formed and heat treating provides the required surface hardness. Since the ratchet no longer has to be machined from stock shapes, the most efficient contour can be employed and formed right in the part. Delivered to Briggs & Stratton, ready-to-use, the Sintaloy part with inherently fine surface finish and close tolerances, minimizes inspection, eliminates further finishing, simplifies inventory, and frees production facilities for other work.

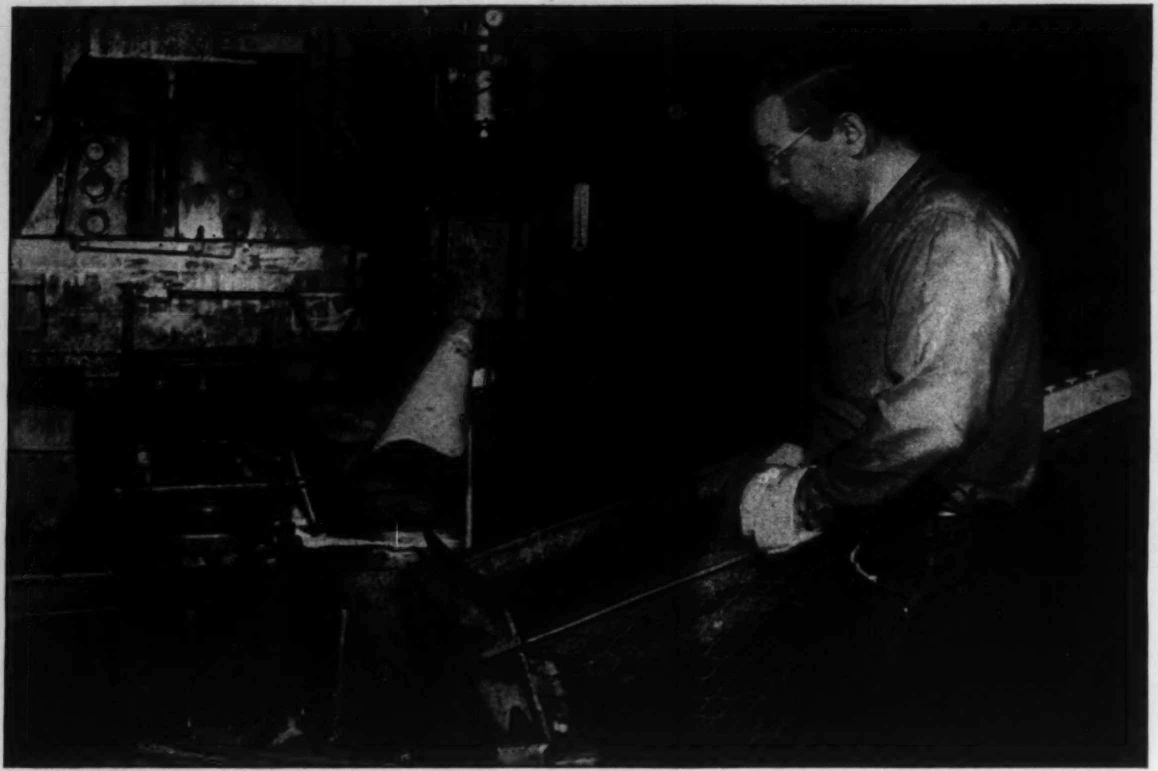
These are but some of the outstanding advantages of Sintaloy Powder Metallurgy in one particular case. It costs nothing to determine how it can also provide similar advantages for you. Write today for illustrated brochure with full design data.

DIXON SINTALOY INC.

a subsidiary of The Joseph Dixon Crucible Company
535 Hope Street, Stamford, Connecticut

Circle 625 on Page 19

Problem-Solving Products from Republic:



Alloy steel billets, four inches square, are fed into a seven-step forging press and emerge at the end as differential ring gear blanks.

REPUBLIC ALLOY STEELS PROVIDE STRENGTH AND TOUGHNESS FOR STRESS-RESISTANT RING GEARS

Fast starts and steep hills require tough, strong, dependable ring gears.

The Ford Motor Company, to maintain its reputation for quality, specifies only the finest steels. Ford uses Republic SAE 4028H series hot rolled Alloy Steel in forging the highest quality ring gears.

Republic Alloy Steel forging billets 4-inches square, are sheared into 5-inch lengths, heated, and put into an automated forging press. The billet goes through seven forging steps, passing from one die to another automatically. After forging the blank is annealed.

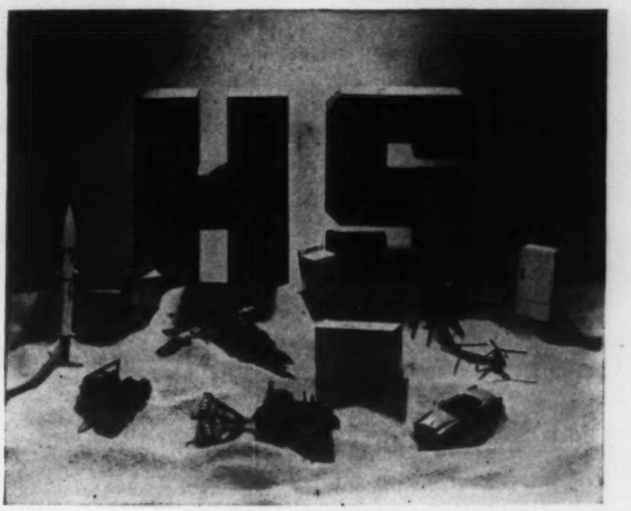
Alloy steels are unusually tough and strong. They can absorb sudden shock and impact without failure. Respond uniformly to heat treatment producing hard, wear-resistant surfaces around tough cores. This tough integral structure provides greater strength with greater dependability.

Field metallurgists working closely with Ford metallurgists and engineers in their own plants provided a metal that is tough and strong enough to withstand shock, impact, stress, and fatigue.

Republic's famed 3-Dimension Metallurgical Service Teams—field, mill, and laboratory metallurgists—are available to help you in selection, application, and processing of the right alloy steel for the job. It's confidential. There's no obligation. Send coupon for more information.

REPUBLIC NYLOK® STUDS solve fastening problem for Gravely Tractors, Inc., Dunbar, West Virginia. Problem: Find a dependable fastening method for tractor-attached rotary cultivators. Fastener must withstand constant shocks and pounding of rotary culvitating. Solution: Use Republic Nylok Studs. A special nylon insert assures positive locking at any position, even under severe shock, vibration, tension. Prevents all play. Utilizes metal-to-metal contact of opposing threads for locking. Republic Nylok Fasteners—studs, nuts, cap screws—resist heat, cold, moisture. Can be re-used. Interested? Mail coupon for full facts.

HARD DRAWN ROUND STEEL SPRING WIRE is providing outstanding performance in automotive seat and back cushions, and in furniture and bedding applications. Performance is assured by Republic quality. Standard High Carbon Spring Wire and MB High Carbon Spring Wire are produced by specialists who know and understand both steelmaking and high carbon wire practices. They know spring forming machines and the importance of physicals, finish, cast, and size accuracy in the finished product. Wire metallurgists will assist you in selection, application, and processing. Send coupon for details.



NEW HIGH STRENGTH POWDER, TYPE HS6460, opens the way for new applications using sinterings for highly stressed parts. Type HS6460 can be used with existing operating equipment. It provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered, 100,000 psi heat treated. Type HS6460 maintains its dimensional characteristics after sintering—less than .004 inches per inch shrinkage from die size at 6.4 density. Available in production quantities up to and including 12 tons, or in multiples thereof. Mail coupon for technical data sheet.

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M•F

gives you product superiority
and fast, low-cost assembly
with the M•F line of lock nuts
and weld nuts in all sizes
"off the shelf"

M•F TWO-WAY LOCK NUT

for faster application with consistent torque

This all-metal, double chamfered, re-usable prevailing torque lock nut can be applied to bolt threads from either end. The center locking principle permits bolt end to be flush with top of nut. Can be reapplied up to 10 times.

Open cap nut with 2 way locking feature

M•F UNI-TORQUE LOCK NUT

for high torque consistency in full and jam thickness

This *prevailing-torque* lock nut will withstand terrific vibration and shock loading; retains its locking ability for as many as 10 RE-applications. This is the lock nut that enables you to predict—*and maintain*—UNIFORM bolt tension.

Flange nut with uni-torque locking feature

M•F PROJECTION WELD NUT

for low-cost assembly

Solve production delays, cut manufacturing costs—fuse nut to the product in exact location. Engineered for assembly simplification. The welding of nuts to sub-assemblies permits the use of screws or bolts in the main assembly without the need for holding nuts from turning, cutting time and labor.

Both types available with the patented M•F Two-Way locking feature. Each type has three welding projections, eliminating rock and guaranteeing a uniform weld.

Pilot type

Recessed type

M•F SPIN LOCK NUT

the nut with the built-in lockwasher

This free-spinning one-piece lock nut eliminates the need for supplemental locking devices such as lockwashers. Cuts purchasing and inventory costs.

WRITE FOR FREE CATALOG

The M•F Products Catalog—valuable data on torque, bolt tension and dimensions as well as on other available products.

MAC LEAN-FOGG Lock Nut Company
5535 N. WOLCOTT STREET • CHICAGO 40, ILLINOIS

Circle 627 on Page 19

(*Continued from Page 329*)

put shaft provided is a 3-in. diam stub shaft with $3/4$ x $3/8$-in. keyway and 5-in. extension. Additional shaft length can be provided when specified. **Cotta Transmission Co.,** Rockford, Ill. K

Circle 977 on Page 19

Flow Regulators

have flexible rubber member for self-cleaning action

Line of flow regulators is available in eight sizes from 2 to 8 gpm. Bodies are brass and tapped $1/2$ in. for sizes through 4 gpm and $3/4$ in. for larger sizes. Control is obtained by change in size and shape of orifice in flexible rubber member. Continual flexing of rubber member makes orifice self-cleaning. Units are accurate to a maximum of 10 per cent ± of rated size when used within range of 20 to 125 psi and temperatures to 160 F. **Taco Heaters Inc.,** 1160 Cranston St., Cranston 9, R. I. B

TACO FLOW
REGULATOR

Circle 978 on Page 19

Inertia Switch

can be mounted in any plane

Combining compactness, lightness, reliability, and accuracy, inertia switch meets military environmental requirements. It can be mounted in any plane to detect acceleration forces caused by roll, pitch, and yaw. Standard unit is factory adjustable from 1 to 3 g, and special units to 50 g can be furnished. Operating temperature range is −55 to +100 C. Switch is single-pole, double-throw and can be adjusted for equal or unequal sensitivity from either direction in one plane through longitudinal axis. Switch reset is auto-

You just roll this sealer on!
3M Ribbon Sealer EC-1202

ROLL-ON RIBBON SEALER EC-1202 creates a uniform, economical, durable seal that shuts out water, dust and moisture.

It's easy to shut wind and weather out of mobile homes with 3M Sealer EC-1202. You just roll this synthetic rubber ribbon on, apply the next piece of metal . . . and fasten mechanically right through the sealer.

Because it's fabric-reinforced, EC-1202 holds its shape, doesn't stretch, sag or shrink. It applies just as easily along curved surfaces.

In mobile homes, this roll-on ribbon makes a weather-tight seal at lap seams and window beddings. And EC-1202 serves boats, curtain walls, commercial refrigeration, too. It's available in various widths and thicknesses direct from your local jobber.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU! Consult 3M Research. Contact your 3M Field Engineer. Or for information and free literature write: A.C.&S. Division, 3M, Dept. YQ-59, 900 Bush Ave., St. Paul 6, Minn.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Circle 628 on Page 19

IT PAYS TO HAVE GOOD CONNECTIONS
HUBBELL

Manufacturers of Cold Headed Fasteners Since 1888

OVER 5 TIMES THE RATE AT 45% LESS COST

Another example of how Hubbell Cold Heading produces Better Parts at Faster Speeds, at Lower Cost

THE PART:
Special 1-64 Miniature Binding Screw

THE MATERIAL:
18-8 High Tensile Stainless Steel

THE METHOD:
Hubbell Cold Heading in place of screw machining

THE RESULT:
a. Production increased from original rate of 7000 pc. p.d. to cold heading rate of 40,000 pc. p.d.
b. Cost reduced 45%
c. Finer Quality—More Economical Production
1. Higher Tensile Strength
2. Cleaner, Stronger Threads
3. No Scrap Waste
4. No Separation from Chips

Hubbell Cold Heading may provide equally dramatic results for you. Whether it is presently cold headed or not, send blueprint of part or sample for analysis and estimate.

HARVEY HUBBELL, Inc. *Machine Screw Dept.*
Bridgeport 2, Connecticut

Kindly estimate on the enclosed
Sample (Blueprint). Quantity ______

Name ______________________
Title ______________________
Company ______________________
Address ______________________

Circle 629 on Page 19

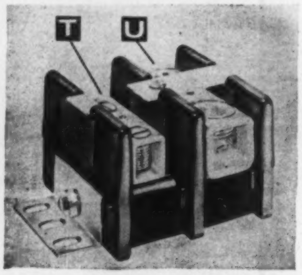
matic, and contacts are rated 100 ma at 28 v dc. Government & Industrial Div., Magnavox Co., Dept. NP, Ft. Wayne, Ind. J

Circle 979 on Page 19

Terminal Blocks

for connecting wire leads without lugs

Types T and U high-current terminal blocks, rated 125 and 250 amp at 750 v, respectively, are designed with tubular-type terminals for connecting wire leads without lugs. Connectors are high-pressure, solderless type, made from electrolytically pure copper to assure 100 per cent conductivity. Type T accommodates AWG No. 6 to No. 1/0 wire and is available with from 1 to 6 terminals per block. Type U, with socket-head screws in tubular-type terminals, accommodates No. 4 to 250 MCM wire AWG. Tightening of wire-clamping screws provides positive, completely positioned connection. Units are also available for connection of leads with lugs. Curtis Development & Mfg. Co., 3250 N. 33rd St., Milwaukee 6, Wis. K



Circle 980 on Page 19

Adjustable-Speed Drive

has torque of 100 lb-in.

Planetary speed reducer incorporated in a mechanical transmission offers high-torque, infinite-range drive with speed ranges of 300 to 0 rpm

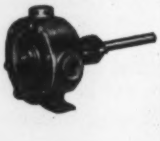
THERE'S A
WAYNE ROTARY TO PUMP ALL!

ROLLING GEAR DESIGN ASSURES HIGHER OPERATING EFFICIENCY

Viscous . . . volatile . . . fast . . . slow there's a Wayne Rotary Pump to pump products more efficiently and at lower costs. Wayne Pumps are of an improved type construction—gear-within-a-gear rotary pump. The positive seal and rolling contact of the tooth design assures pump service never before obtainable . . . less down time . . . fewer replacements. Write for new catalog.

RUGGED DUTY PUMPS
For installations where operating conditions are unusually severe. Capacities 35, 50, 70, 100, 200 and 300 gpm.

HAZARDOUS LIQUID PUMPS
Furnished with any type of drive—gear, V-belt or direct. Complete with relief valve. Listed under re-examination service of U.L.

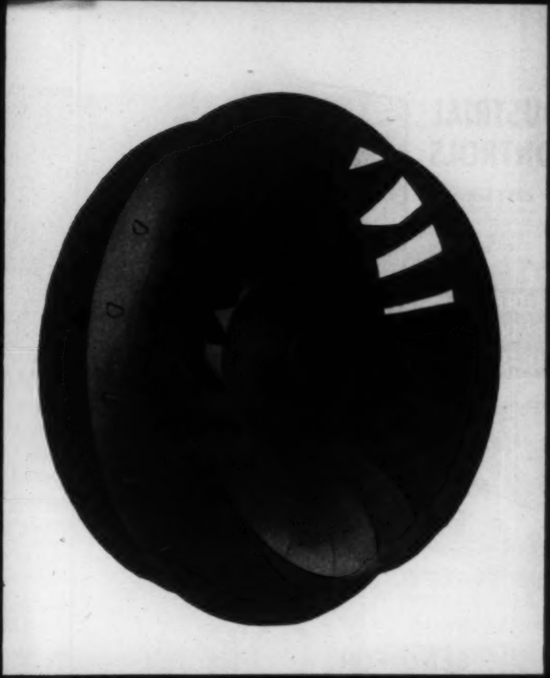


STANDARD SERVICE PUMPS
Available in capacities of 3, 5, 10, 18, 20, 25, 35, 50 and 100 gpm. Ports right or left on all models. Straight through also on 3 and 5 gpm models.

THE WAYNE PUMP COMPANY
Industrial Division
FORT WAYNE 4, Indiana
Division of Symington Wayne Corporation

Wayne
PUMPS

Circle 630 on Page 19



TORRINGTON CRACKS THE NOISE PROBLEM The squeeze toward compactness in room air conditioners has forced the decibel level up to the point that *noise is now the No. 1 problem.* ▌ In anticipation of this trend, two years ago Torrington's air impeller laboratories went to work on "noise." ▌ The result is the revolutionary Torrington H Wheel—one of the most important breakthroughs in air conditioning history. ▌ In one room air conditioner application test the H Wheel reduced the noise level from 63 to 53 decibels; and it was less than *one half as loud.* ▌ Torrington's engineering department is now offering samples of the H-Series Wheel for evaluation in your new product development program.

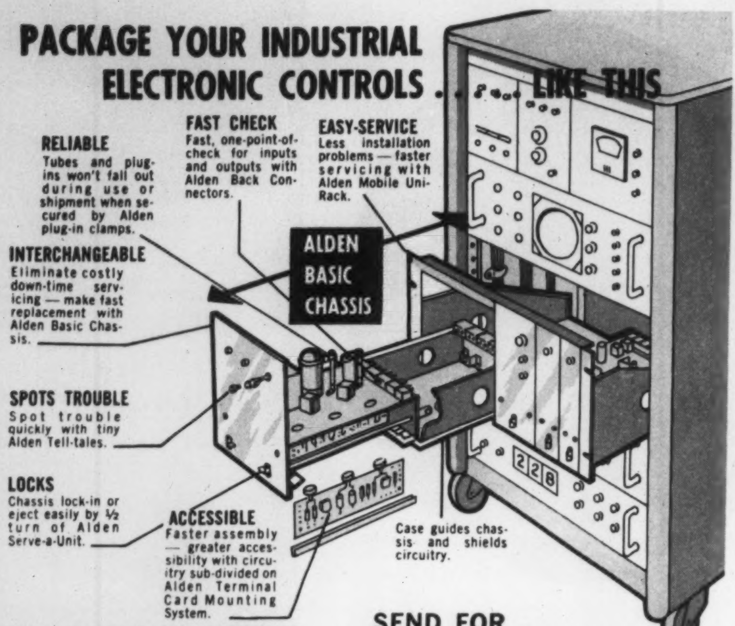
THE TORRINGTON MANUFACTURING COMPANY

TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

$$\frac{1}{2}$$

Circle 631 on Page 19

PACKAGE YOUR INDUSTRIAL ELECTRONIC CONTROLS . . . LIKE THIS


FAST CHECK
Fast, one-point-of-check for inputs and outputs with Alden Back Connectors.
EASY-SERVICE
Less installation problems — faster servicing with Alden Mobile Uni-Rack.
RELIABLE
Tubes and plug-ins won't fall out during use or shipment when secured by Alden plug-in clamps.
INTERCHANGEABLE
Eliminate costly down-time servicing — make fast replacement with Alden Basic Chassis.
ALDEN BASIC CHASSIS
SPOTS TROUBLE
Spot trouble quickly with tiny Alden Tell-tales.
LOCKS
Chassis lock-in or eject easily by ½ turn of Alden Serve-a-Unit.
ACCESSIBLE
Faster assembly — greater accessibility with circuitry sub-divided on Alden Terminal Card Mounting System.
Case guides chassis and shields circuitry.

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Now — you can lay out and package a unit or system — breadboard to production — with standard "off the shelf" Alden Electronic Packaging components for plug-in, modular construction. Especially suited for building engineering models, prototypes, custom instruments, test gear, controls, etc. Used widely by private and government labs, universities, and industry.

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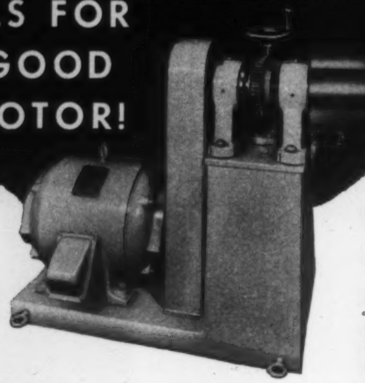
ALDEN PRODUCTS CO., 5149 N. Main Street, Brockton, Mass.

Circle 632 on Page 19

A GOOD MACHINE CALLS FOR A GOOD MOTOR!



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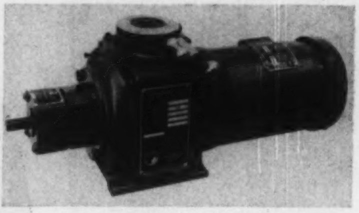
Circle 633 on Page 19



and 1 to 0 revolutions per hour. Speeds can be set with an accuracy of one part in 4000. Reducer develops torque of 100 lb-in. Built-in overload protection prevents damage to reducer, transmission, or driven machinery. In-line design saves space and permits a package of motor, adjustable-speed drive, control, and reducer that is mounted with four bolts. Micrometer control is shown, but transmission is also available with a variety of other controls. It is also available without motor or with built-in motor of other specifications. **Graham Transmissions Inc.**, Menomonee Falls, Wis. K

Circle 981 on Page 19

Stainless Alloys

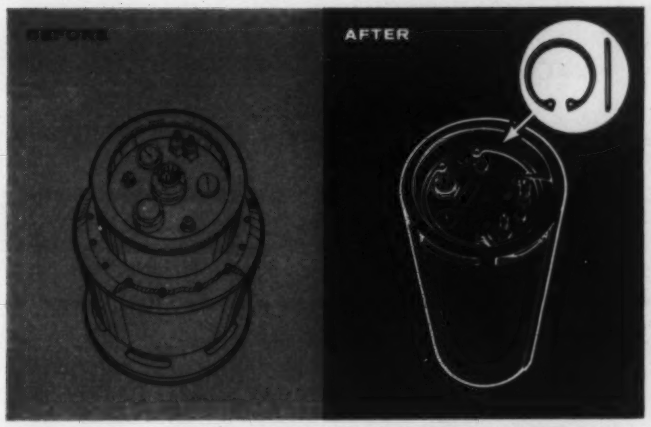
18-8 types have high strength and hardness

Molybdenum-containing alloys of 18-8 type have excellent resistance to corrosion, particularly of pitting type, and to detrimental effects of velocity and suspended abrasions. High strength and hardness permit use in high temperatures (1000-1400 F). Alloy PH55A has high strength, high hardness, and excellent pitting resistance. It is suitable for applications where Type 316 will not stand up. Alloy Ph55B has high strength, greater ductility, and lower hardness, making it suitable in applications where corrosion-resistant parts are subject to stress and shock. **Cooper Alloy Corp.**, Bloy Street & Ramsey Avenue, Hillside, N. J. D

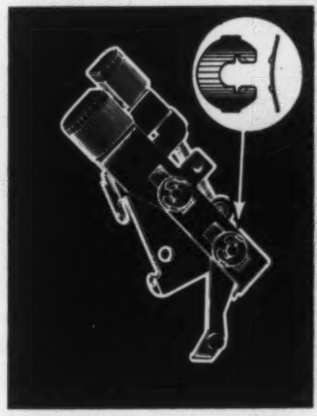
Circle 982 on Page 19

Silicon Diode

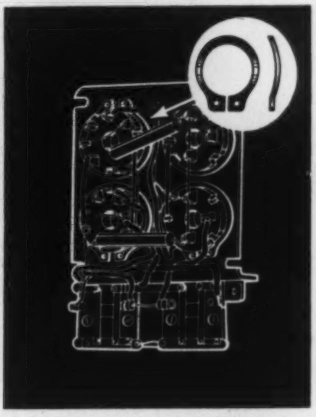
No. 1N2175 subminiature, light-sensing photoduodide, made by Texas Instruments Co., was incorrectly described in the April 2 issue as passing less than 0.5 ma in darkness. Correct figure is 0.5 mu amp.



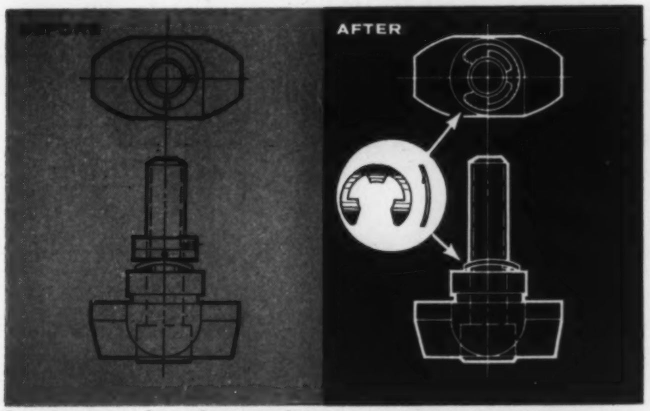
Pressure cover design simplified. Two axially assembled Truarc Series 5002 beveled rings eliminate 27 bolts, reduce machining and assembly time from 78 to 1½ hours and make possible drastic size and weight reductions. Rings retain two covers of a pressurized x-ray unit. **Savings: about $500 per unit.**



Parts eliminated in slide assembly. Two radially assembled Truarc Series 5139 Prong-Lock® Rings provide proper spring tension, eliminate looseness and wobble in this office calculator shift-slide. Original design called for a cut washer, spring washer, and cotter pin—all eliminated.



New way to install electron-tube sockets. Easy-to-apply Truarc Series 5101 bowed external rings lock tube sockets to chassis plate in this assembly. Bowed construction takes up tolerances of molded grooves, thickness of base. Individual sockets are removable for field service.



Quarter-turn clamp improved. A bowed washer and two locknuts were eliminated in this quarter-turn jig-and-fixture clamp by a Truarc Series 5131 bowed E-ring. The radially assembled ring holds the screw captive, provides required rotational drag between parts with sufficient tension to insure tight fit when the screw is first engaged. **Typical savings: $1.35/unit—assembly up 70%.**

Truarc rings for end-play take-up offer significant design advantages

A number of Truarc retaining rings are available to take up end-play or loose fit caused by accumulated tolerances and wear. The rings often eliminate spring washers, collars and set screws, nuts, bolts, rivets, cotter pins and other conventional fastening devices with outstanding cost savings in machining and assembly time.

Truarc retaining rings designed to deal with the end-play problem are of two general types: **bowed rings** for resilient end-play take-up and **beveled rings** for rigid end-play take-up.

Bowed retaining rings are widely used for pre-loading bearings, preventing vibration or oscillation in linkages, providing tension on adjusting screws. Of particular interest is the radially installed Truarc Prong-Lock® ring which locks securely to the shaft by means of two prongs. It provides exceptional thrust load capacity, may be used as a shoulder against rotating parts, and often eliminates springs, bowed washers and other tensioning devices.

In beveled rings for rigid end-play take-up, the groove-engaging edge is beveled at 15°. There is a corresponding bevel on the load-bearing groove wall. To take up end-play, the ring acts as a wedge between the outer groove wall and the part being retained.

These are just a few of the 50 functionally different types of Truarc retaining rings. They come in up to 97 standard sizes, six metal specifications, 13 different finishes. The entire line as well as accessory assembly tools, grooving tools, and over 70 typical applications are shown in the new catalog RR 10-58. Write for your copy today. And remember Waldes Truarc engineers are always ready to work with you on your specific projects. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

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WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor, Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS... THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

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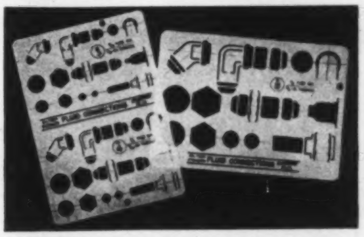
EQUIPMENT

Drafting Templates

. for fluid connections

Five templates for fluid connections feature an arrangement of symbols to allow fittings to be drawn completely without undue shifting of template. Based on MIL standards, symbols cover major fittings, side and front elevation. Numbered 63 through 67, templates cover tube sizes 3, 4, 5, 6, 8, 10, 12. Templates are mathematical quality double-cured plastic, 0.03 in. thick, with matte finish. Cutouts are precision milled for accuracy and smoothness of line. **Rapidesign Inc.**, P. O. Box 429, Burbank, Calif. L

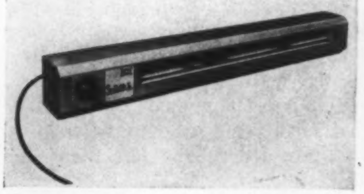


Circle 983 on Page 19

White-Print Machine

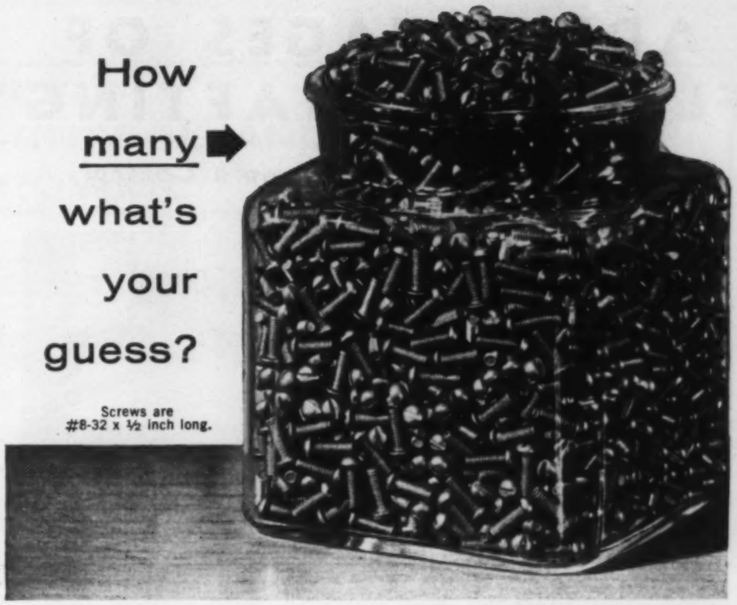
portable unit produces prints to 30 in. wide

Portable rotary diazo white-print machine, designated Satellite, is 44 x 5 x 5 in. in size and weighs less than 30 lb. It can be wall mounted or placed on a small desk or table, and operates from any 115-v convenience outlet. Unit produces white prints of any length and to 30 in. in width from any translucent original. Standard fluores-



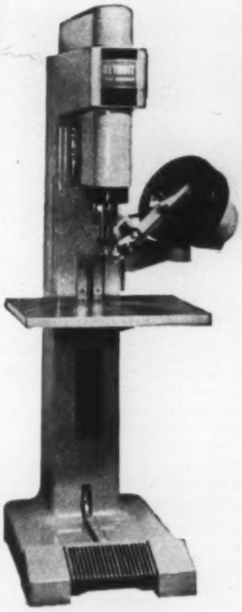
How
many ➡
what's
your
guess?

Screws are
#8-32 x ½ inch long.



One man can drive them in one hour

with a DPS power screwdriving machine



The new DPS Model U screwdriving machine.

Why sacrifice manpower on so simple yet tedious a job as driving screws? Free skilled hands for more productive work . . . get higher output per happier manhour—with a DPS power screwdriving machine.

To illustrate, one worker can drive the 2,400 screws in the jar above in one hour. And with no more effort than pressing an air-operated foot pedal. Equally important, they're driven through an easily adjustable clutch, designed to hold constant driving torques.

NEW! THE MODEL "U"—At left, meet the great, new DPS Model "U" screwdriving machine—quickly adaptable for fast, clean driving of screws, nuts and studs. New folder contains full data. Write for your copy today.

15,048

DETROIT POWER SCREWDRIVER
COMPANY
2801 W. Fort St. Detroit 16, Michigan
A Subsidiary of Link-Belt Company

Circle 636 on Page 19

ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by

C. Hotchkiss, Jr.

Application Engineer

Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative-motion.

2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

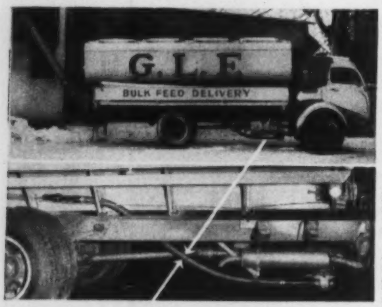
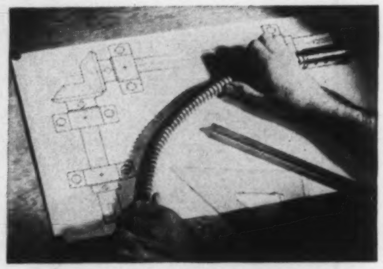


Fig. 1



Relative Motion — Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛-inch to 1¼-inches; for remote control applications in diameter sizes from ⅛-inch to 1⅝-inches. The 1¼-inch power drive shaft will transmit up to 10 HP while the 1⅝-inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 570.

STOW MANUFACTURING COMPANY

11 SHEAR STREET • BINGHAMTON, NEW YORK

Circle 637 on Page 19

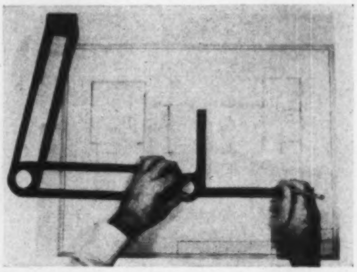
cent tube, adapted for white printing, insures intense light needed for quality prints. One front dial with selective speed variations permits exact exposures. Reversal control provides for emergency return. **Grico Inc.**, 1279 Munroe Falls Ave., Cuyahoga Falls, Ohio. F

Circle 984 on Page 19

Portable Drafting Unit

has 6 x 9-in., one-piece, interchangeable scale

Retaining features of smaller model, Draftette Senior 12 folds to fit into a briefcase and can be opened to attach to drawing board, desk, or table in seconds. Unit is constructed of aluminum, black anodized, and features one-piece, 6 x 9-in. interchangeable scale with white numerals which cannot rub off. It is divided into 16ths or 10/50ths, with 360-deg protractor. Covering 400 sq-in. of drawing surface, unit replaces T-square, rulers, protractor, and triangles. It is completely assembled, ready to use on lightweight 20 x 26-in. drawing board. Total weight is 3½ lb. **David Miller & Associates**, Box 572, Beverly Hills, Calif. L



Circle 985 on Page 19

Tape Reader

reads at any speed to 1000 characters per sec

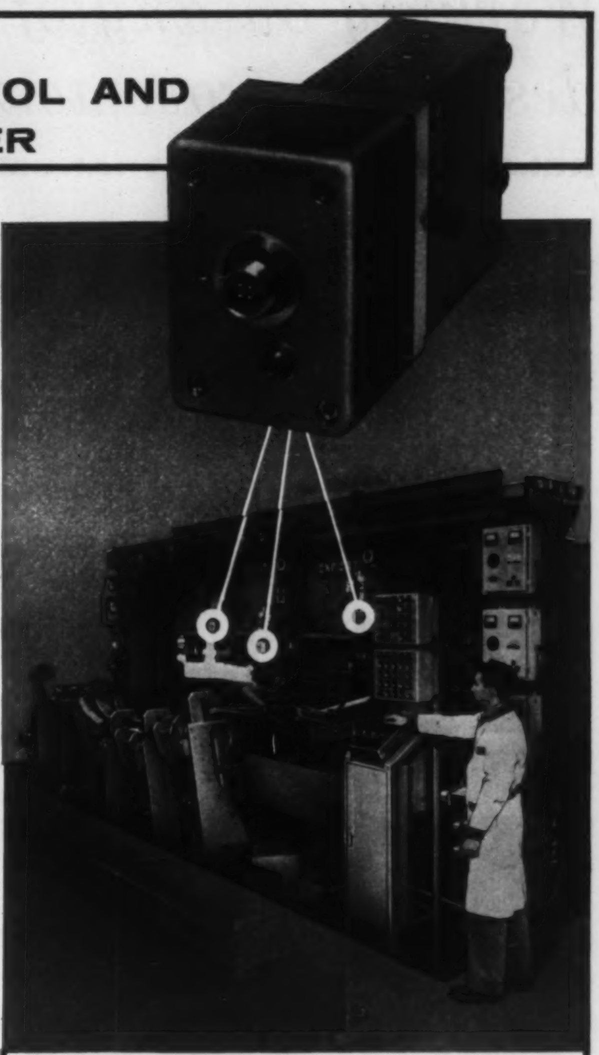
Self-contained, free-standing tape reader operates under either computer or manual control and reads character by character at high speed. TR7 unit includes spooling, photosensing head, amplifiers, control circuits and power supplies, all fully transistorized. It reads 5, 7, or 8-level tape at any speed up to 1000 characters per sec. Fast rewind is also provided, giving less than 30 sec rewind time for 1200 ft of tape.

THE LINK BETWEEN ELECTRONIC CONTROL AND HYDRAULIC POWER

Expert Welding Machine Co. Solves the High Production Contour Welding Problem With

VICKERS

Electro-Hydraulic Servo Valve



The versatility of electro-hydraulic control of power has solved one of industry's toughest problems—automatic welding of complex and contoured automotive frame members.

An electronic probe follows the weld line on the work and records any deviation from the path prescribed by a master cam. Any deviation from the governing cam contour creates an error signal which is amplified and fed to the servo valve. The servo valve converts these electrical signals into precise hydraulic flow to a cylinder which accurately positions the welding head allowing for variations in manufacturing operations . . . trimming, etc.

This application is only one of many in which Vickers Servo Valve has demonstrated exceptional performance under the exacting conditions of industrial production requirements.

Valve operation is simple. Reliability is assured—there are only four moving parts.

Investigate the production advantages offered by electro-hydraulics. **Write for Vickers Engineering Bulletin 58-74.**

EXPERT WELDING MACHINE COMPANY developed this automated welding machine that incorporates a magnetic-tape-tracer system. Vickers electro-hydraulic servo valve provides the link between electronic programming and hydraulic power. Vickers Pumps and Controls also used. The machine joins metal parts having untrimmed, out-of-tolerance, straight and/or contoured weld line edges.

VISIT VICKERS
DESIGN ENGINEERING SHOW EXHIBIT No. 1428

Two U-shape channels are welded to form the box configuration in this complex automotive frame side member. Production is approximately 100 pcs/hr.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Working on any of these design improvements

RELATED TO TORQUE TRANSMISSION? .... *more capacity*

greater angles

no torsional vibration

higher speeds

longer shaft life

extended bearing wear

If so, and if your application warrants placing the solution and ultimate cost-savings above ordinary, lower priced joint designs . . . RZEPPA can help you. Here's why:

By transmitting a uniform flow of power through ball bearing action, RZEPPA *Joints operate with less friction; carry heavier loads and are more compact than any other type of joint . . . size for size.*

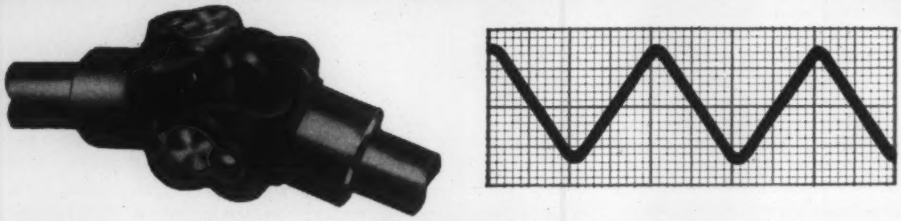
RZEPPA Constant Velocity Joints are available for *light, medium* and *heavy* duty on air and space craft, vehicles and industrial machinery.

WRITE FOR LATEST LITERATURE or send your dimensional sketch with peak horsepower, R.P.M. and operating angles. Without obligation, our engineers will assist you. Address: THE GEAR GRINDING MACHINE COMPANY, Dept. DJ-559, 3901 Christopher St., Detroit 11, Michigan.

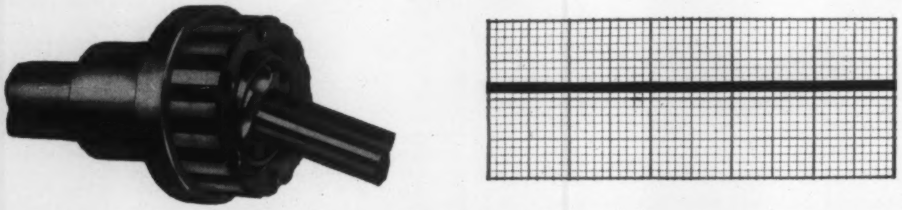
RZEPPA CONSTANT VELOCITY UNIVERSAL JOINTS

(PRONOUNCED: "SHEPPA")

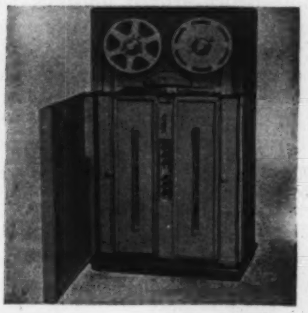
Genuine RZEPPA Joints are made exclusively by THE GEAR GRINDING MACHINE CO.



ORDINARY CROSS OR PIN UNIVERSAL JOINT — Mathematics and geometry prove this joint changes velocity of the driven shaft with two high points and two low points per complete revolution. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.



CONSTANT VELOCITY JOINT — This RZEPPA design joint *always* transmits smooth torque even at unbalanced angles. Such smooth torque action results from ball bearings applying power in a plane that bisects both shaft axes.



Double-row reading head permits each character on tape to be read twice. Readings are compared by a built-in comparator circuit. Unit is 27¾ in. wide, 20 in. deep, 52 in. high. **Electronics Div., Ferranti Electric Inc.,** 95 Madison Ave., Hempstead, L. I., N. Y. D

Circle 986 on Page 19

Drafting Film

uses 0.004-in. polyester photographic film base

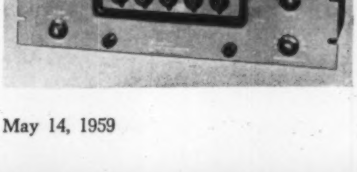
Available with either one or two sides matte-finished for ready acceptance of pencil and ink, Cronaflex drafting film permits repeated erasures without detrimental effect upon matte surface and without ghosting. Title-block printing, with fast-drying inks, can be used on either matte or nonmatte sides. Film utilizes 0.004-in. polyester photographic film base which has one-third the tensile strength of steel and is virtually tearproof. Film can be creased without damage to matte surface, and is unaffected by moisture. Wide variety of common solvent-cleaners can be used on film without adverse effect. **Photo Products Dept., E. I. duPont de Nemours & Co. Inc.,** Wilmington 98, Del. C

Circle 987 on Page 19

Digital Voltmeter

makes 50 measurements per second

Model 8409 all-electronic digital



ACCO
Helicoid
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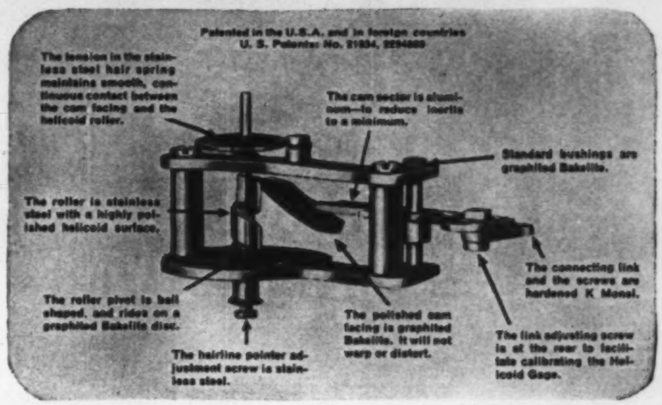
Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21834, 2294883
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides...
Sustained Accuracy... on the toughest jobs

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

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HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.
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ACCO

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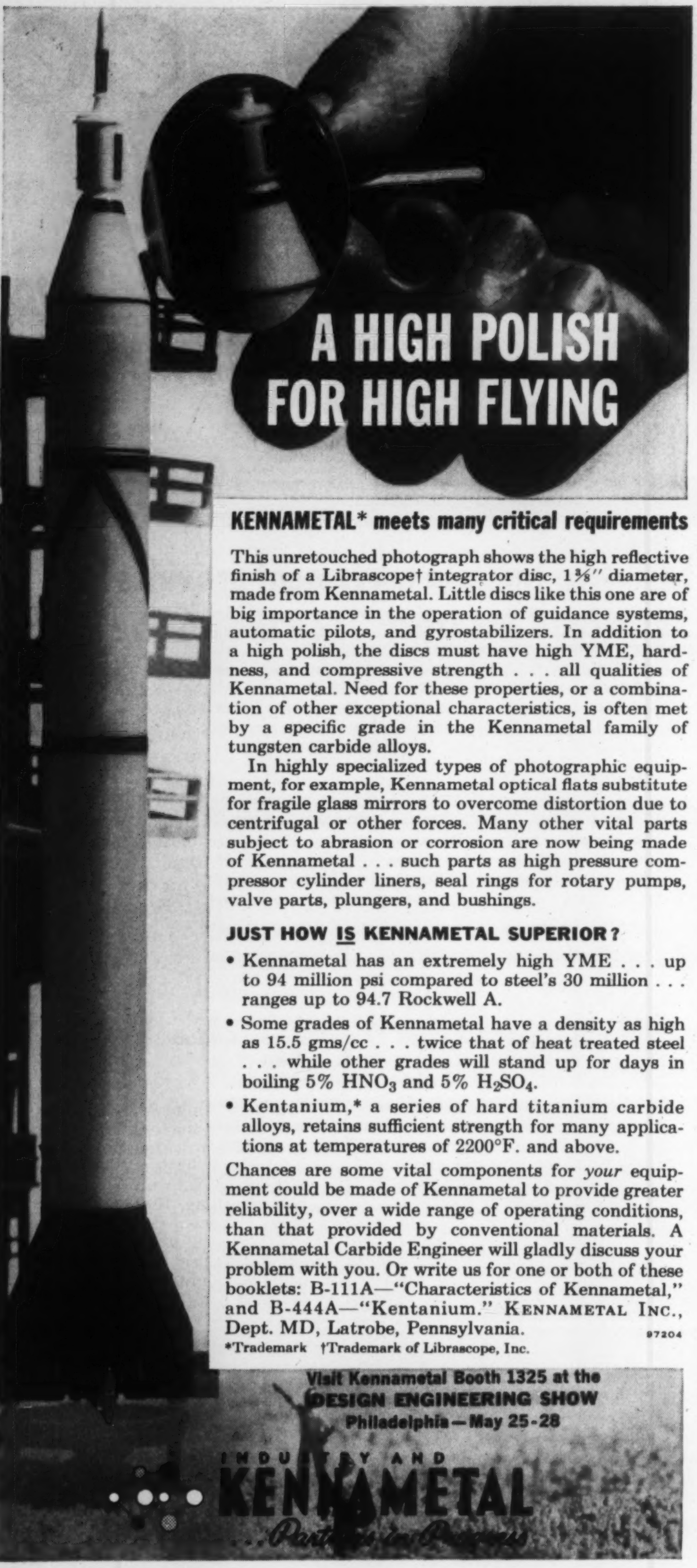

KENNAMETAL* meets many critical requirements

This unretouched photograph shows the high reflective finish of a Librascope† integrator disc, 1⅜" diameter, made from Kennametal. Little discs like this one are of big importance in the operation of guidance systems, automatic pilots, and gyrostabilizers. In addition to a high polish, the discs must have high YME, hardness, and compressive strength . . . all qualities of Kennametal. Need for these properties, or a combination of other exceptional characteristics, is often met by a specific grade in the Kennametal family of tungsten carbide alloys.

In highly specialized types of photographic equipment, for example, Kennametal optical flats substitute for fragile glass mirrors to overcome distortion due to centrifugal or other forces. Many other vital parts subject to abrasion or corrosion are now being made of Kennametal . . . such parts as high pressure compressor cylinder liners, seal rings for rotary pumps, valve parts, plungers, and bushings.

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- Some grades of Kennametal have a density as high as 15.5 gms/cc . . . twice that of heat treated steel . . . while other grades will stand up for days in boiling 5% HNO_3 and 5% H_2SO_4.
- Kentanium,* a series of hard titanium carbide alloys, retains sufficient strength for many applications at temperatures of 2200°F. and above.

Chances are some vital components for *your* equipment could be made of Kennametal to provide greater reliability, over a wide range of operating conditions, than that provided by conventional materials. A Kennametal Carbide Engineer will gladly discuss your problem with you. Or write us for one or both of these booklets: B-111A—"Characteristics of Kennametal," and B-444A—"Kentanium." KENNAMETAL INC., Dept. MD, Latrobe, Pennsylvania. 97204

*Trademark †Trademark of Librascope, Inc.

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Circle 641 on Page 19

voltmeter is a medium-speed unit capable of making 50 measurements per second. The four-digit voltmeter features totally transistorized logic circuits, plus or minus one-digit accuracy, automatic polarity, and automatic, manual, and remote ranging. Input impedance is 1000 megohm. Unit also has direct printer operation, provision for external reference voltage, and modular construction throughout. **Electro Instruments Inc.**, 3540 Aero Court, San Diego, Calif. L

Circle 988 on Page 19

Vertical File

has adjustable height up to 66 in.

Mobile Rolling Stand vertical file is 24 in. wide and, when equipped with brackets and binders, accommodates up to 1200 large sheets. Redesigned unit has adjustable height to accept filing sheets of any length to 66 in. Stand is 14-gage tubular steel, finished in gray baked enamel. **Plan Hold Corp.**, 5204 Chakemco St., South Gate, Calif. L

Circle 989 on Page 19

Operations Monitor

is 30-channel, transistorized unit

RE-3303-00 operations monitor records 30 channels of on-off, open-shut, pulse, or event-type information. Fully transistorized electric writing system is unaffected by ambient conditions, and provides instantaneous, dry, permanent record. Wide range of chart speeds provides signal resolutions as small as 0.004 sec. Unit weighs only 20 lb. **Brush Instruments Div., Clevite Corp.**, 37th and Perkins Avenue, Cleveland 14, Ohio. G

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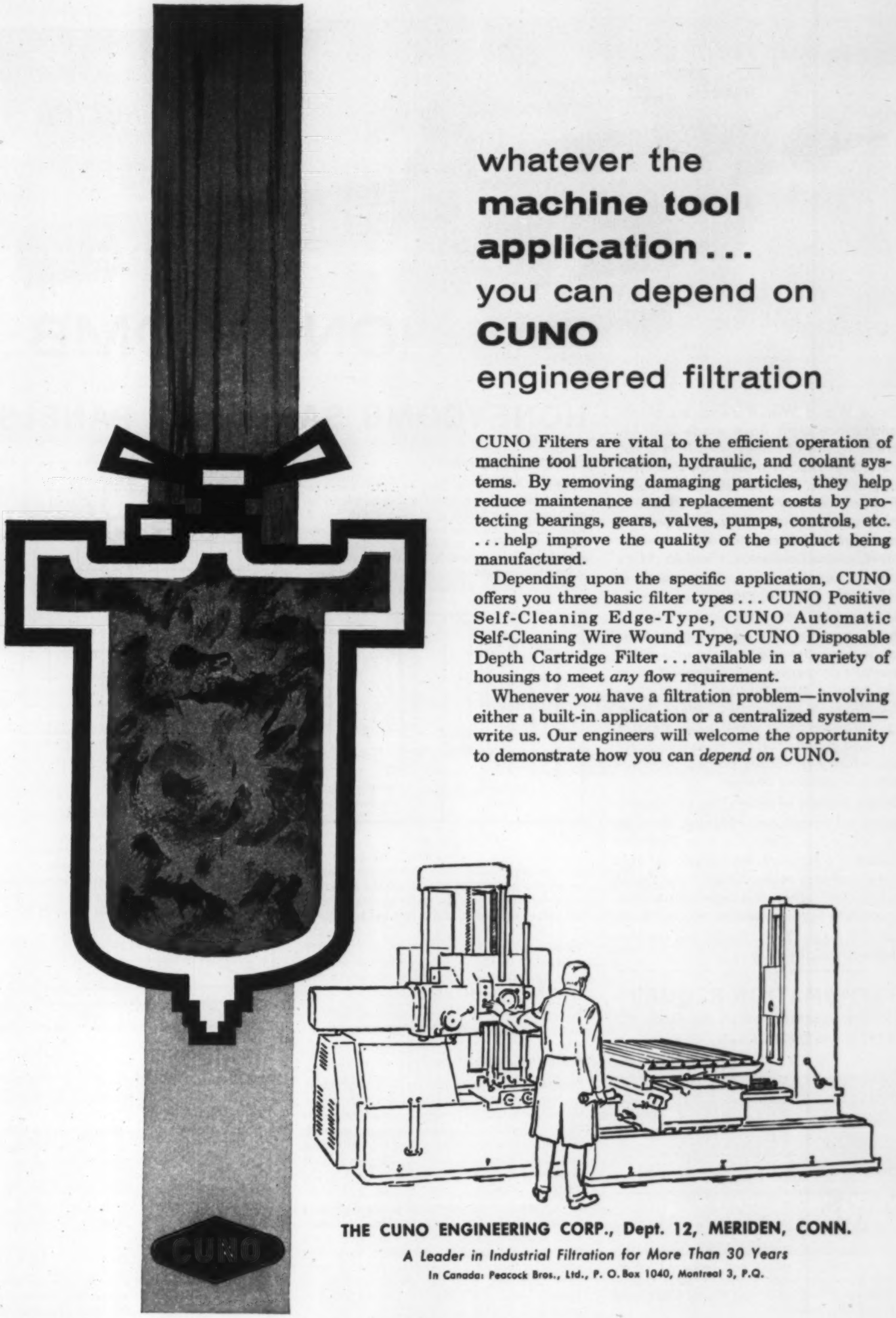

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Honeycomb has intrinsic qualities of high strength, light weight, high ratio of surface area to volume and other specific properties which depend upon the type of material used. These combinations of properties, which have given honeycomb wide application in air and space craft, offer to designers in industry generally unique opportunities in product design.

In the interest of advancing this knowledge of honeycomb, Hexcel, through its research and development staff (the industry's largest), has prepared this informational series. Should you desire additional technical information, please complete the information request form on this page. Your request will receive immediate attention.

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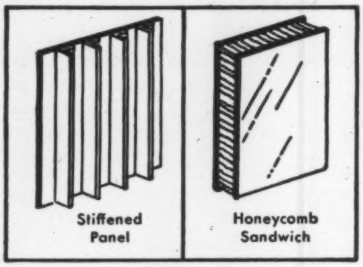
HONEYCOMB SANDWICH PANELS

Strength/Weight Ratio

Traditional design of flat panel structures to resist bending or column loading has been to use either thick plates or thin sheets stiffened with angle extrusions to form a more or less rigid panel. Where end use of panel requires a high stiffness-to-weight ratio or a superior strength-to-weight ratio, many designers have turned to the use of sandwich structure.



Sketch #1

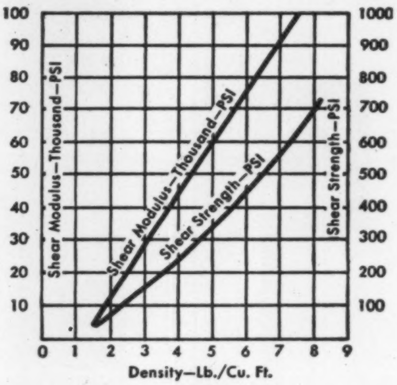
In a sandwich structure, the panel is made up of two faces with a light weight core material between them. In order to qualify as a structural sandwich, the core must be rigidly attached to the two faces. When these requirements are met, the resulting structure is capable of the highest strength-to-weight and rigidity-to-weight ratios presently obtainable by ordinary design methods.

Sandwich Structures:

A Design Approach

Sandwich structures are really a method of design approach rather than a single material. It is possible to design structures precisely tailored to fit the requirements at hand. Not only can the thickness and type of facing material be varied, but the thickness and density of the core material is subject to the designer's choice.

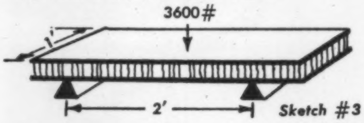
In the two curves shown, shear strength and shear modulus are given for Hexcel aluminum honeycomb in densities ranging from two to eight pounds per cubic foot. The strengths these core materials develop compare favorably with the strength of much heavier cores of plastic foam, wood fibers or other less efficient materials.



Sketch #2

Bending Loads

Bending strength and the bending rigidity of sandwich panels are two primary reasons for their broad acceptance in the area of light weight structures. In comparing panels loaded as shown in the sketch below, it can be shown that honeycomb sandwich is by far the lightest of any usable structure.



Sketch #3

3600 LB. WEIGHT - - - - - 24" SPAN		
Material	Deflection (in inches)	Weight (in pounds)
Honeycomb Sandwich	.058	7.79
Nested "I" Beams	.058	10.86
Steel Angles	.058	25.9
Aluminum Plate	.058	34.2
Magnesium Plate	.058	55.0
Steel Plate	.058	68.6
Glass Reinforced Plastic Laminate	.058	83.4

The list of weights and deflections in the above table gives a clear indication that honeycomb sandwich panels have broad areas of application.

THE ENGINEER'S Library

Recent Books

Dynamical Analogies. *By Harry F. Olson; 278 pages, 6 by 9 in., clothbound; published by D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N. J.; available from* MACHINE DESIGN, $6.75 *per copy postpaid.*

The author uses familiar systems as analogies to simplify analysis of unknown fields. Various problems in complicated dynamic systems are converted to the most widely known vibrating system, the electric circuit, and solved.

While retaining the original analogies for electrical, acoustic, and mechanical rectilinear and rotational systems, this second edition includes new analogies for magnetic, noise, distortion, feedback, and velocity-force systems. The chapter on practical applications has been enlarged accordingly.

Transactions of the Fifth Conference on Mechanisms. 239 *pages,* 8½ *by* 11 *in., paperbound; published by and available from Penton Publishing Co., Reader's Service Dept., Penton Building, Cleveland* 13, *Ohio;* $3.00 *per copy postpaid.*

These transactions contain 19 papers presented at the 1958 Mechanisms Conference co-sponsored by Purdue University and MACHINE DESIGN. Major topics are cams, linkages, and computer components. Other papers discuss measurement as a design tool, high-speed movies for motion analysis, and techniques for studying 3-D mechanisms. Papers are complete with illustrations, tables, and equations.

Mathematics Dictionary. *Edited by Glenn James and Robert C. James;* 546 *pages, 6 by 9 in., clothbound; published by D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N. J.; available from* MACHINE DESIGN, $15.00 *per copy postpaid.*

Definitions and condensed mathematical concepts are given for terms encountered in arithmetic

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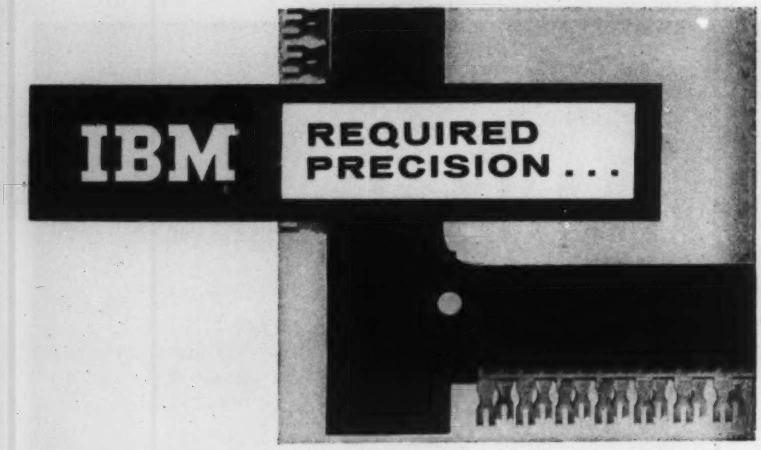

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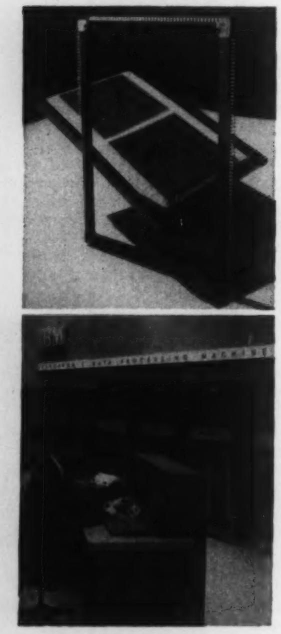

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through calculus. Included are basic terms of real and complex variables, differential geometry, matrices, summability, analytical mechanics, potentials, and statics.

Additions to this second edition include basic terms for modern algebra, number theory, topology, vector spaces, theory of games, linear and dynamic programming, computing machines, and numerical analysis. Tables and symbols are given in the appendix. Formulas appear throughout the text. Indexes for French, German, Russian, and Spanish give English word equivalents.

Professional Creativity. *By Eugene K. von Fange; 260 pages, 5½ by 8⅜ in., clothbound; published by and available from Prentice-Hall Inc., 70 Fifth Ave., New York 11, N. Y.; $4.95 per copy.*

Based upon his experience, the author reveals what is and is not necessary for repeated success in creative adventure. After explaining what creativeness is and that everyone has creative talent, the book tells how to use one's mental powers and resources to create. Next discussed are details of planning creative work to insure that: 1. Worthwhile objectives are established. 2. The creative work itself is conducted efficiently. 3. Results, when achieved, are acceptable to others.

Engineering Mechanics. *By H. L. Langhaar, professor of theoretical and applied mechanics, and A. P. Boresi, associate professor of theoretical and applied mechanics, both of University of Illinois; 705 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$9.00 per copy postpaid.*

General ideas of mechanics and their interpretation are stressed in this textbook. Greater emphasis on mechanics of nonrigid systems provides a basis for later study of fluid mechanics and mechanics of deformable bodies. Elementary vector notation is used to aid understanding of the physical ideas involved.

In addition to normal treatment of concurrent and coplanar forces in statics, three-dimensional statics

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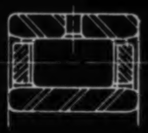

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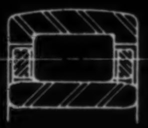

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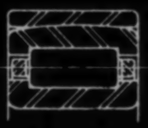

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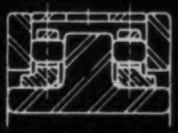
FROM "FEATHERWEIGHT" TO "HEAVYWEIGHT" SECTIONS

TWO DIRECTION THRUST



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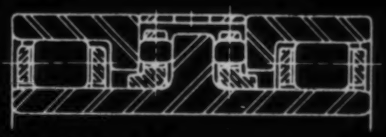

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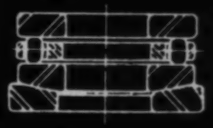

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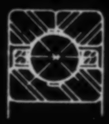

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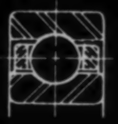
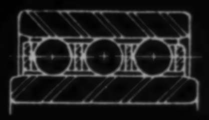


BALL THRUST

RECIPROCATING BALL



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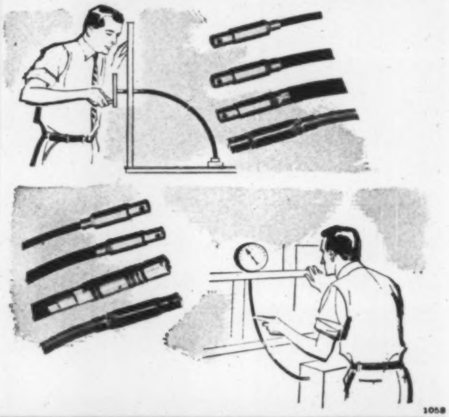

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and related analytic geometry are developed. Also discussed are curvature theory, centripetal and tangential acceleration, kinematic and dynamic frames of reference, physical dimension theory, planetary motion, vibration, and mass and energy concepts.

Applied Mathematics for Engineers and Scientists. *By C. G. Lambe, associate professor of mathematics, Royal Military College of Science; 518 pages, 5½ by 8½ in., clothbound; published by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y.; available from* MACHINE DESIGN, $8.50 *per copy postpaid.*

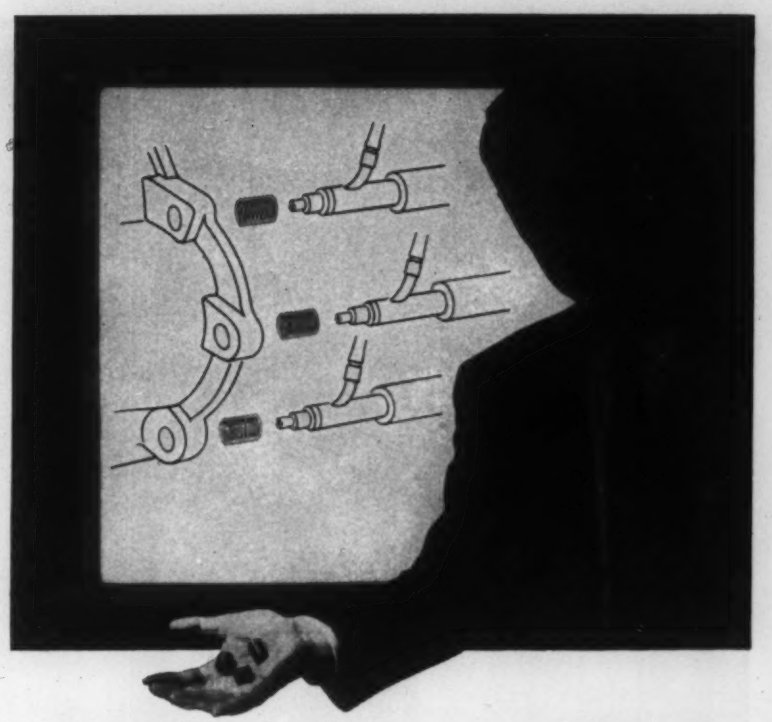
A practical approach is presented for mathematical analysis of problems found in dynamics, statics, hydromechanics, and wave motion. Broad subject coverage permits servomechanisms and electric circuits to be treated under oscillation of particles. Fourier series is included in vibrations, and the gyroscope is discussed under Lagrange's equations.

Structural statics deals with beam deflection and strut theory. Stability of flotation and theory of stream functions are covered under fluid motion. Legendre and Bessel functions are derived and applied to boundry-value problems for Laplace's equation and heat flow.

Creep of Engineering Materials. *By Iain Finnie and William R. Heller; 341 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, $11.50 *per copy postpaid.*

Current knowledge on creep and design for creep conditions is presented in this book. Behavior of both metals and nonmetals is explored. Creep testing, measurement of creep variables, and accuracy as well as limitations of available information are discussed. The book also shows how to conduct stress analysis under creep conditions and how to select a design stress.

Mechanics—Part II: Dynamics. *By J. L. Meriam, professor of engineering mechanics, University of California; 420 pages, 5¾ by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave.,*



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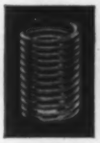

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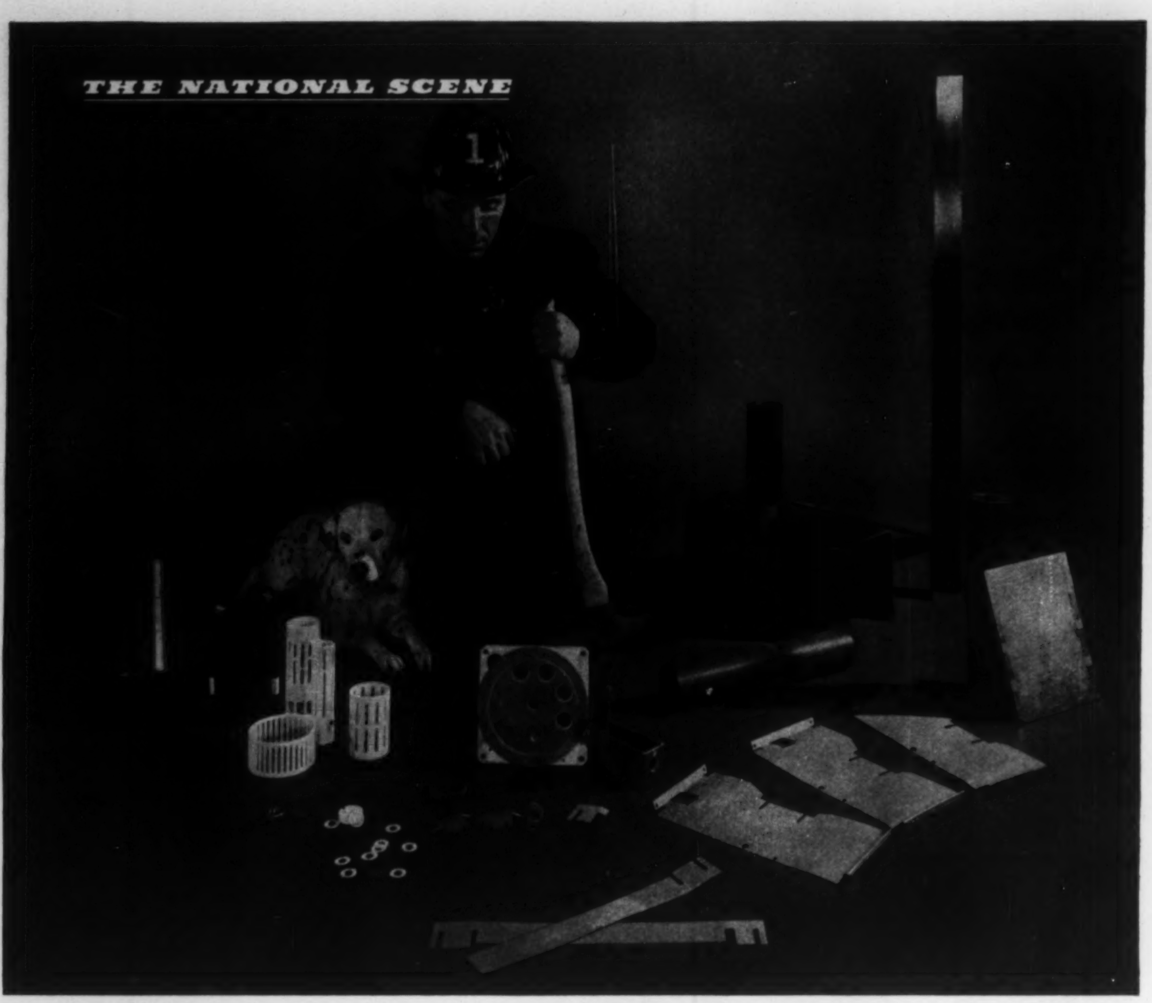


"Where can flame-retardance improve your product; make it safer . . . function better . . . or sell faster?"

Choose from 11 National Materials—in sheets, tubes, rods, formed shapes, or precision-fabricated parts

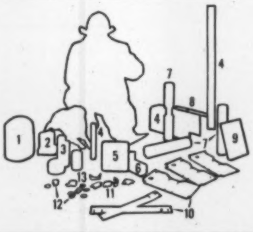
Computers, high-voltage switchgear, home appliances, television receivers, radios and radar . . . aircraft and missile instrumentation . . . in fact, with any product where fire is a potential, flame-retardant laminates pay-off in design features and product protection.

The "pay-off" comes in protection of lives and expensive equipment from fire, because these materials are self-extinguishing. As barriers, base plates, terminal boards, support members, printed circuits—National's family of flame-retardant materials is solving problems of fire containment and those involving *both* fire and electrical insulation.

Surprisingly, *low cost* is a feature of several of these materials. And since they mean more safety and product protection for the user, the "pay-off" also comes in the form of added product sales features.

Write for complete property values on these eleven materials, and let us know what your particular problem is. If you wish samples and price information, drop us a note on your letterhead. National Vulcanized Fibre Co., Dept. G-5, Wilmington 99, Delaware.

Grade	Base	Resin	Extinguishing Time (sec.) UL
PYRONIL	Cellulose	None	<1
X-121	Paper	Phenolic	2-4
X-122	Paper	Phenolic	1
XX-326	Paper	Phenolic	1½-2
XXXP-475	Paper	Phenolic	<1-1½
GP-9202	Glass Mat	Polyester	<1
GP-9204	Glass Mat	Polyester	<1
G-5-813	Glass Cloth	Melamine	<1
G-7-832	Glass Cloth	Silicone	<1
GH-871	Glass Cloth	Phenolic	<1
EP-491	Paper	Epoxy	<1



1. Weldor's Shield. **2.** Box. **3.** Coil Forms. **4.** Circuit Breaker Parts. **5.** Coil Form Base. **6.** Film Splicer Housing. **7.** High Voltage Bushings. **8.** Bus Bar Insulator. **9.** Printed Circuit. **10.** Portable TV Shields. **11.** Switch Shields. **12.** Switch Plates. **13.** Stand-Off Insulator.

Circle 649 on Page 19

CHOOSE FROM THESE MATERIALS...

Vulcanized Fibre: 10 standard grades; many special grades.

PHENOLITE® Laminated Plastic: over 80 standard and modified grades; paper, cotton fabric, nylon, asbestos, glass fabric, cotton and glass mat bases; phenolic, melamine, polyester, epoxy, teflon or silicone resins.

PEERLESS Electrical Insulation: coil, strip, corrugated.

Extruded Nylon: 2 grades; rod, strip, pressure tubing, special shapes.

Polyester Glass Mat: 4 standard sheet grades; custom molded shapes.

PHENOLITE Copper-Clad Laminates: 10 standard grades.

Combination Materials: Rubber-PHENOLITE; Rubber-Fibre; Wood-Fibre; Metal-Fibre; Asbestos-Fibre; PEERLESS-PHENOLITE.

BACKED BY THESE SERVICES...

Field Application Assistance
Complete Fabricated Parts Service
Stock Program for Immediate Shipment

BY CALLING THESE OFFICES...

Baltimore	VAlley 3-0393
Boston	TWinbrook 4-3500
Chicago	AUstin 7-1935
Cincinnati	GArfield 1-0632
Cleveland	ERieview 1-0240
Dallas	DAvis 4-4386
Denver	Main 3-2077
Detroit	UNiversity 3-3632
Griffin, Ga.	8-1308
Indianapolis	WAlnut 3-6381
Los Angeles	RAymond 3-0291
Milwaukee	BRoadway 6-6995
New Haven	LOcust 2-3594
Newark	MItchell 2-6090
New York	COrtlandt 7-3895
Philadelphia	SHerwood 8-0760
Pittsburgh	FAirfax 1-3939
Rochester	Hillside 5-0900
St. Louis	PArkview 5-9577
St. Petersburg	5-5505
San Francisco	DAvenport 6-4667
Seattle	MElrose 2-7298
Wilmington	OLympia 5-6371

IN CANADA:
National Fibre Co. of Canada, Ltd.

Toronto	LEnnox 2-3303
Montreal	AVenue 8-7536

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE
In Canada:
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

New York 16, N. Y.; available from MACHINE DESIGN, *$5.00 per copy postpaid.*

Selected engineering problems help stress the advantage of analyzing the complete operating system as often found in applied mechanics. This preference for considering entire systems is the basis of a new work-energy concept presented in this second edition.

Separating the simple motion of particles and rigid bodies into absolute and relative motion permits a more detailed analysis in the chapter on kinematics. The force-mass-acceleration section is also divided to present concurrent force systems of particle kinetics as a basis for understanding the nonconcurrent forces of rigid-body kinetics.

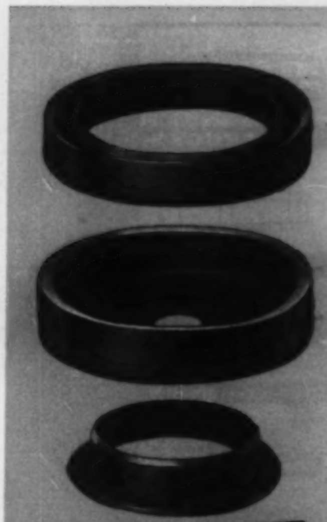
Graphical Communication. *By Earl D. Black; 328 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.00 per copy postpaid.*

Techniques used for technical drafting, sketching, and blueprint reading are presented. Covered are drafting practices, graphical views, working and process drawings, layouts, and presentation of numerical data. Problems require graphical solutions for a wide range of three-dimensional conditions. Included are tables, formulas, and information on threads, pipes, washers, keys, gages, pins, gears, plane figures, and physical data for construction materials.

Manufacturers' Publications

The Language and Symbology of Digital Computer Systems. 114 *pages, 6 by 9 in., clothbound; published by and available from Govt. Service Dept. (Bldg. 210), RCA Service Co., Camden 8, N. J.; $2.00 per copy.*

This reference book describes the basic principles and characteristics of digital computer systems. Boolean algebra, the science of symbols and their combinations as used to describe and represent mathematical functions according to rules of logic, is discussed in practical terms. Terminology and symbols preferred by Air Force Cambridge Research Center are presented. These symbols



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in Viton A, Vyram, Polyurethane, and other unusual elastomeric materials having excellent resistance to many petroleum oils, synthetic lubricants, fuels, phosphate and silicate ester fluids—in a temperature range of —40° to + 500°F.

LINEAR—specialists in close-tolerance molding in all of today's modern polymers . . . in both fabric reinforced and homogeneous materials.

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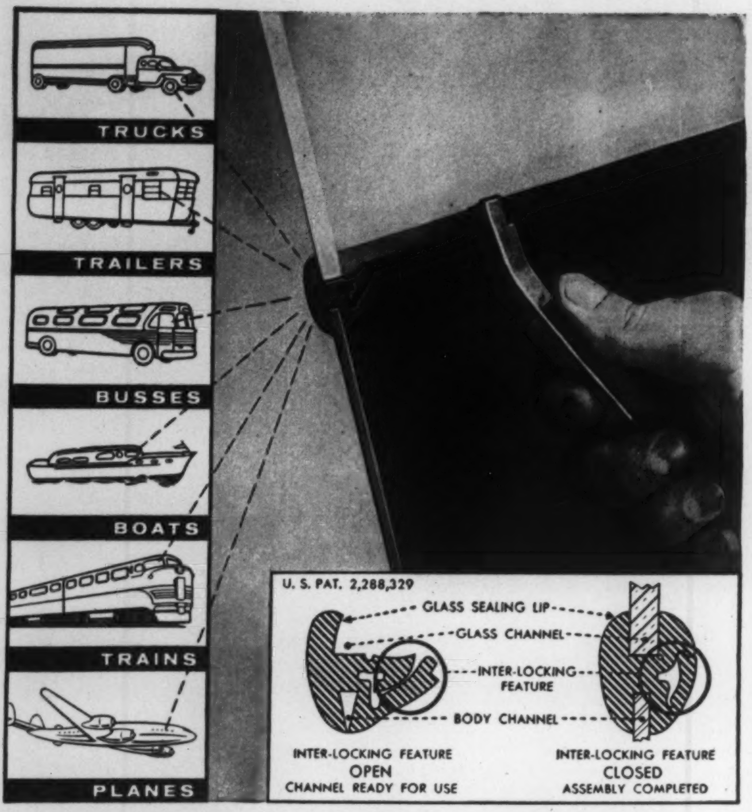
Circle 650 on Page 19



Self-Locking Rubber Channel for Mounting Glass in Body Panels

Its *one-piece* design locks and seals in one operation. No extra locking-strip needed. It's the faster, simpler method for mounting glass in any type body panel—truck, trailer, bus, boat, train, plane, etc.

Extruded with inter-locking feature at direct right angle to body, the Continental Channel permits unhampered insertion of glass. Locking tongue is pressed into its matching groove which forces the lips against *both* the glass and body panel—a more positive seal with exceptional push-out pressure.

Compounded for maximum weather resistance and extra long life. Close durometer tolerances are held for uniformly tight seal against moisture and surest possible locking. These rubber channels can be positioned first on *either* glass or body panel. All details are shown in illustrated brochure gladly sent on request.

Ordered and re-ordered by the most prominent body builders, this Self-Locking Channel is another example of the creative thinking and ingenuity behind rubber parts by Continental. When you need rubber parts to do a specific job, call a rubber specialist *during the planning stage*. This often makes for economy as well as better end results. Call Continental—rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
CR *engineered by* **CONTINENTAL**

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Circle 651 on Page 19

are cross-referenced with symbols used in Burroughs, IBM, RCA, and Remington-Rand Univac systems.

Government Publications

NASA Memorandums. *Copies of memorandums listed below are available from Division of Research Information, National Aeronautics and Space Administration, 1520 H St. N. W., Washington 25, D. C.*

Memo 2-12-59L. Compression Tests on Circular Cylinders Stiffened Longitudinally by Closely Spaced Z-Section Stringers. By James P. Peterson and Marvin B. Dow, Langley Research Center; 22 pages, 7¾ by 10¼ in., paperbound, side-stapled.

Stiffened cylindrical shells, longitudinally stiffened flat panels, and unstiffened cylinders were made of 7075-T6 aluminum alloy. Buckling and postbuckling behavior is reported. Test results are compared with theoretical results.

Memo 2-24-59W. Theoretical Determination of Lifetime of Compressed Plates at Elevated Temperatures. By George Herrmann and Hu-Nan Chu; 21 pages, 7¾ by 10¼ in., paperbound, side-stapled.

Linearized equations are used with the assumption that plate material is a standard linear solid. Lifetime is determined by reducing time-dependent behavior to time-independent response of purely elastic buckling. Predicted lifetime of 2024-T3 aluminum alloy at 450 F is compared with experimental values.

NASA Reports. *Copies of reports listed below are available from Superintendent of Documents, Government Printing Office, Washington 25, D. C.*

AGARD Report 60. Post Buckling Behavior of Structures. By A. van der Neut; 33 pages, 8 by 10½ in., paperbound, stapled.

Investigates effect of increasing load-carrying capacity beyond buckling load for flat plates; attempts to find the relation between edge displacements of a panel and its load and between increments of buckling and stiffness. Solutions for flat plates at constant temperature and for thermal loading are compared with experimental evidence.

AGARD Report 158. Some Fundamental Features of Mechano-Chemical Attack on Metals. By T. P. Hoar; 5 pages, 8 by 10½ in., paperbound, stapled.

Discusses behavior of, and effects produced by, oxide films under conditions leading to their chemical failure and under fretting, fatigue, and static-stress conditions.

OTS Technical Reports. *Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

PB 131686. Plastics and Adhesives: A Guide to Their Physical Properties and Uses. By Lawrence R. Dallett and William E. Donaldson, U. S. Naval Ordnance Test Station; 107 pages, 8 by 10½ in., paperbound, side-stapled; $2.50 per copy.

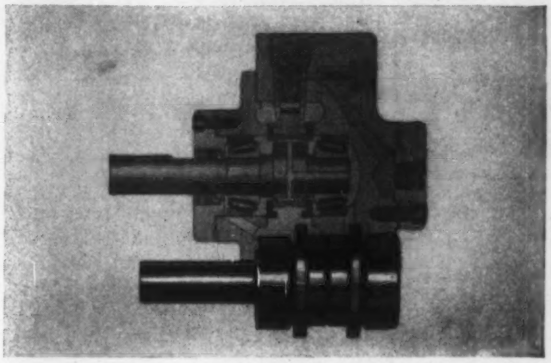
Contains selected facts and references available as of March, 1955; describes properties and uses of the more common plastics; tabulates physical properties and engineering data of representative plastics; describes fabricating methods and design of molded parts; shows how to calculate stresses developed in reinforced-plastic tubes; discusses theoretical and practical aspects of adhesives.

PB 151166. Reference Index of the Current Protective Coatings Specifications. 159 pages, 5½ by 8½ in., paperbound, side-stapled; $3.00 per copy.

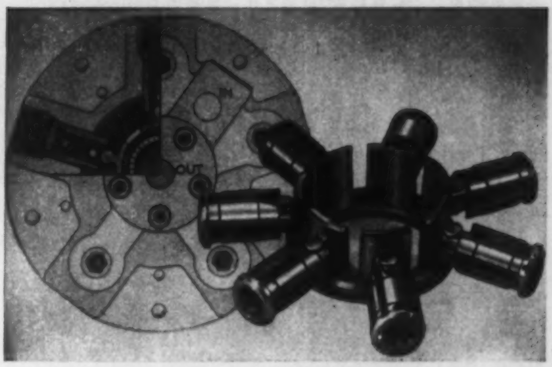
Indexed federal, military, and contractor specifications include protective coatings for aircraft, paints, metal platings, ammunition, tubing, and wheel finishes; new specifications list superseded or comparable specification numbers; requirements, guides, and classifications accompany the specifications.

FOR PRESSURES TO 5,000 PSI . . .

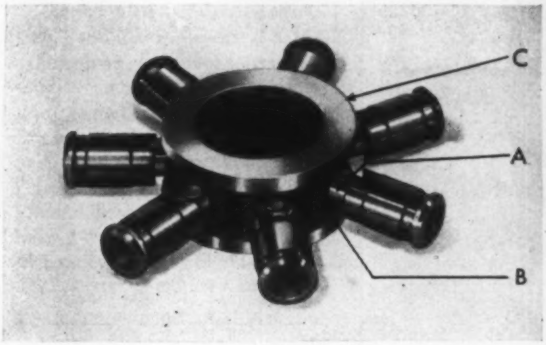
Only the AE Hydramite gives you these 4 key benefits



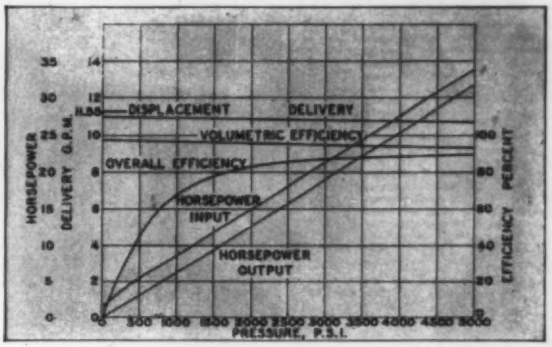
1. Tapered roller bearings. Two high capacity, heavy duty tapered roller bearings support the eccentric cam shaft. This means that a Hydramite can take more punishment . . . handle heavier unbalanced loads . . . and last longer. The pump casing is ported so that the pumping action of tapered bearings will provide better lubrication.



2. Curved slippers riding on the outer race of the cam shaft needle bearing minimizes scrubbing action between these parts. They also distribute thrust loads of the plungers and reduce unit stresses to the point where maintenance will never be required at what is a critical wear point in most hydraulic pumps.



3. Positive pumping action. The Hydramite has no cam follower springs to fail. Plungers (A) are connected to curved slippers (B) which are held against the outer race of cam shaft needle bearing by two plunger return rings (C). As the shaft revolves, each plunger is pushed outward in succession and then pulled back by the return rings.



4. High efficiency. With a Hydramite you get an overall efficiency of 85%. Shown above is typical 10 gpm pump curve. Its flat overall high efficiency has little variation between 1,500 and 5,000 psi. What's more, with a Hydramite you get positive suction. There is no need for supercharging equipment which reduces system efficiency.

To meet your specific requirements, Hydramite pumps can be supplied for constant displacement from 3 to 30 gpm at 5,000 psi and 70 to 85 gpm at 3,000 psi for hydraulic fluids with viscosities of 150 to 300 ssu at 100° F. In special applications they have handled viscosities as low as 40 and as high as 900 ssu at 100° F.

Special materials and seals permit handling of missile fuels and special fluids at higher temperatures. Available in flange, foot or face mounted styles. Write or call American Engineering Company, Dept. P-147, Philadelphia 37, Pa. Phone: CUmberland 9-3800.

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Circle 652 on Page 19

From the shaft out through the Leland nameplate...

Single phase—capacitor start, induction run

Polyphase

. . . integral horsepower motors by Leland offer proven quality. Created and built with the same design flexibility, quality materials, and inflexibly rigid quality control that keep Leland the *world's leader* in motors for the petroleum industry, where Leland Underwriters' Listed fractionals and integrals outsell all others combined. Here are several of many reasons why specifying Leland integrals for almost any use means specifying *lifetime satisfaction.*

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of American Machine & Foundry Company

1. FULL-STRENGTH PROTECTIVE EXTERIOR—one-piece cast iron center frame with double-supported base mounting pads—super-rigid throughout. Cast iron end-frames carefully machined provide absolute bearing support and alignment, and establish uniform air-gap.

2. BEARINGS—Oversize, double-shielded, with high radial and thrust capacity—pre-lubricated.

3. ROTOR ASSEMBLY—virtually indestructible, solid pressure cast aluminum, integrally cast double fans, shafts ground *all over.* Skewed rotor slots and controlled balance for quiet, vibrationless power.

4. STATOR ASSEMBLY—a *superior electrical and mechanical* construction. Pressure stacked core of uniformly punched and *scientifically annealed* laminations gives *superior magnetic characteristics. Cuffed, laminated mylar slot insulators, plus slot feeder insulator,* protects insertion of *heavy formvar insulated copper windings,* then secured with waxed maple pegs. *Inter-phase protective insulation* and sleeved lead stubs are all double linen cord laced; finally the entire assembly is *pre-heated and double dipped and baked in synthetic insulating varnish.*

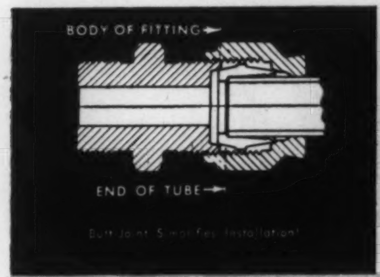
5. CONDUIT BOXES—Large capacity, diagonally split box makes easy connections a cinch on polyphase motors. Single phase units further provide a convenient terminal board plus ready access to capacitors or thermal—all in an ample cast iron box. Either type mounts up, down, right, or left.

For more information, contact our representatives in all principal cities, or write or wire us direct.

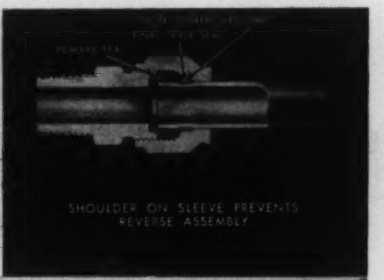
Circle 653 on Page 19

IMPERIAL *Engineering and Data File*

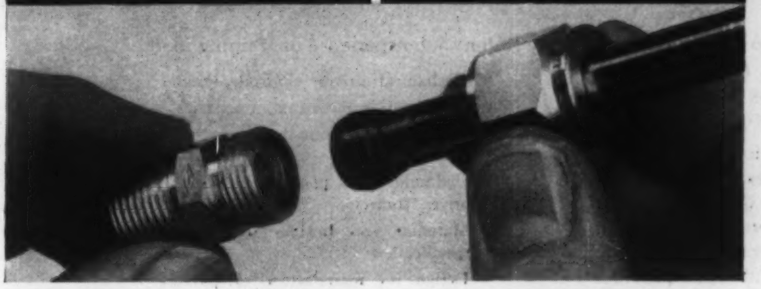
ENGINEERED TUBE FITTINGS — VALVES — TUBING TOOLS



Butt Joint Simplifies Installation!



SHOULDER ON SLEEVE PREVENTS REVERSE ASSEMBLY



How Hi-Seal tube fitting design simplifies hydraulic circuit installations

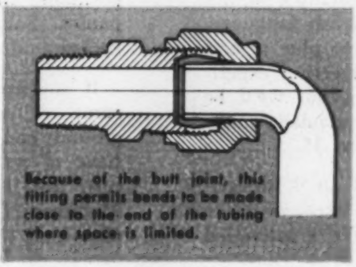
The butt-joint feature of Hi-Seal fittings is a design consideration acclaimed by fitting users throughout industry. The tube *does not* enter body of fitting! It bottoms on the shoulder of the sleeve. This butt joint feature makes possible far more compact piping layouts than other fittings.

Users have obtained these benefits: (1) cuts space requirements up to 50%; (2) reduces number of bends required; (3) cuts man hours and installation time; (4) substantially reduces the amount of tubing needed.

Hi-Seal design eliminates the need to spring tubing. This is important when working with large diameter, heavy wall or hard temper tubing. And bends can be made closer to end of tube than with any other fitting.

FOOLPROOF ASSEMBLY — Anyone can make leakproof connections with Hi-Seal fittings. There is only one way to assemble the Hi-Seal fitting . . . only one way tubing can go into sleeve . . . only one way sleeve can go into fitting.

Hi-Seal design also makes maintenance of equipment easier through quicker disassembly and assembly of joints — may be disconnected and reconnected as often as desired.

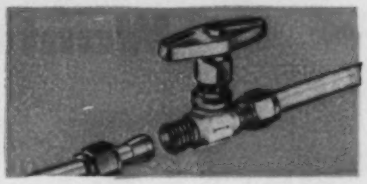


Because of the butt joint, this fitting permits bends to be made close to the end of the tubing where space is limited.

COMPLETE LINE — Hi-Seal fittings are available in brass, steel, stainless steel. Also can be furnished in Titanium, Tantalum and other metals. Steel fittings supplied with cadmium plate or black phosphate finish. Conform to J.I.C., A.S.M.E. and A.S.A. standards. In sizes for ⅛" to 1½" O.D. tubing. Furnished with Long Dryseal pipe threads or straight thread port seal.

Write for Bulletin No. 3061

New high-pressure valves assemble directly to tubing, eliminate additional fittings



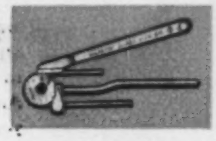
A revolutionary new line of Imperial needle valves designed for working pressures up to 5,000 psi., and temperatures to 450° F., employs Hi-Seal tubing connections.

These valves attach directly to tubing and eliminate additional fittings. This not only reduces cost but cuts installation time and eliminates principal source of leakage.

For low pressure service, Imperial also supplies a complete line of fluid control valves in diaphragm, plug, (2, 3, and 4-way styles) — needle and toggle types.

Write for Bulletin 3096, or Catalog No. 200

Dimensional Bends easily made with Imperial Blue Dot Benders



It's no trick to make bends at any desired point — that conform to dimensional requirements as to developed tube length and location — when you use Imperial Blue Dot Benders. Full instructions with each bender.

Imperial Benders are of the open side type. They slip over the tubing where the bend is desired — handy in hard-to-get-at places or when tubing has one end connected.

They form neat, accurate bends on hard or soft tubing without annealing. Calibrated for bending any angle up to 180°.

Wide range of individual and combination benders for 2 to 7 sizes — from ⅛" to ⅞" O.D. (⅛" to ¾" nom.).

Write for Bulletin No. 3088

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Circle 654 on Page 19

Wanted: Engineers

with an interest in writing

Like to break into an interesting field where you'll make good use of your engineering talents — yet have a chance to develop new skills?

We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

You don't have to have actual writing or editing job experience, although we expect definite ability in handling the English language. An ME or EE degree plus several years of design-engineering experience would be ideal, but we'll be happy to consider equivalent qualifications. Age: 25 to 35.

If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

- Mechanical drives, controls, systems
- Mechanical components, assemblies
- Electrical or electronic drives, controls, systems
- Hydraulic or pneumatic systems, drives, controls
- Materials and finishes selection or specification
- Design for manufacture or production design

Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

MACHINE DESIGN

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Are you open-minded about methods of permanent fastening? If so, it will pay you to call in your nearby Thomson Fastening Man. Ask him to look at your new-product sketches or old-product assembly lines. Chances are, he can tell on the spot whether you can speed production or cut costs with time-tested automatic positioning and fastening techniques. If not, he'll pass your problem, drawings or samples along to his home-office engineers who know when riveting beats stapling, welding, cementing and other permanent fastening methods.

Your Thomson Fastening Man sells by giving shirt-sleeve service. He's more interested in solving fastening problems than in selling rivets. So, use him freely as your direct contact with 74 years of fastening experience. Why not make a date with him soon? Write today to Dept. MD.

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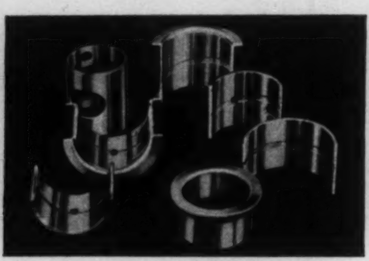
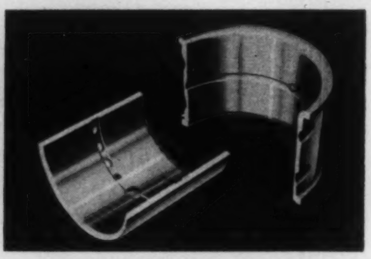
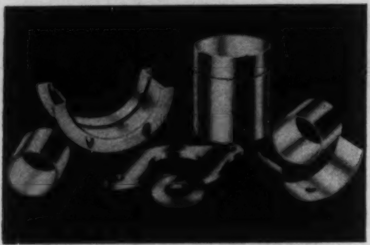
CAST BRONZE



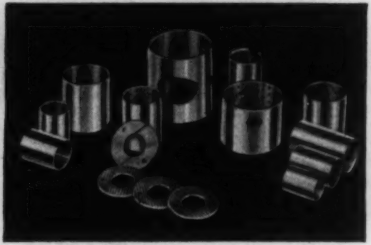
BABBITT AND STEEL



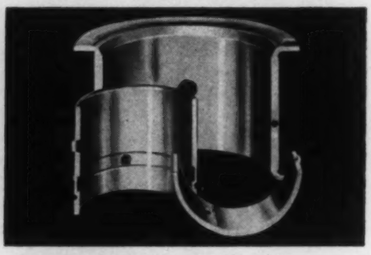
BABBITT AND BRONZE



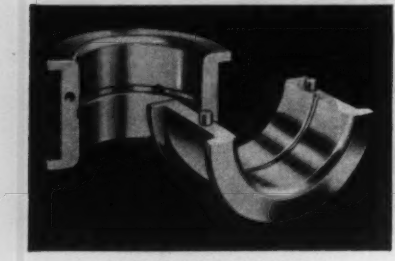
BRONZE OR COPPER-LEAD ON STEEL



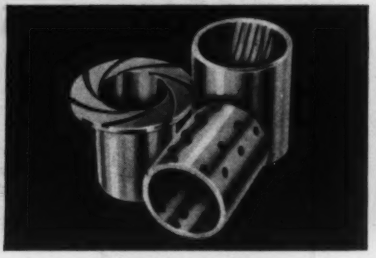
ROLLED BRONZE



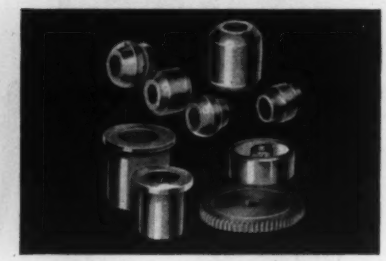
ALUMINUM ON STEEL



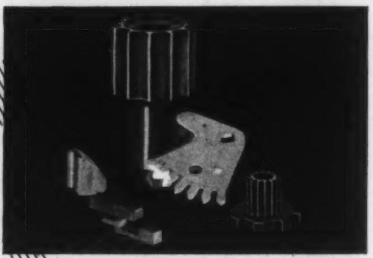
CAST ALUMINUM ALLOY



GRAPHITED BRONZE



LEDALOYL SELF-LUBRICATING



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Johnson Bronze can provide the solution. We produce all types of sleeve bearings in a number of standard sizes. In addition, we have the facilities to produce an infinite variety of custom-made bearings to your specifications. The best bearing for any application can be found among the types illustrated above. To get the exact bearing you need at reasonable cost, contact Johnson Bronze Company, 525 S. Mill Street, New Castle, Pa.

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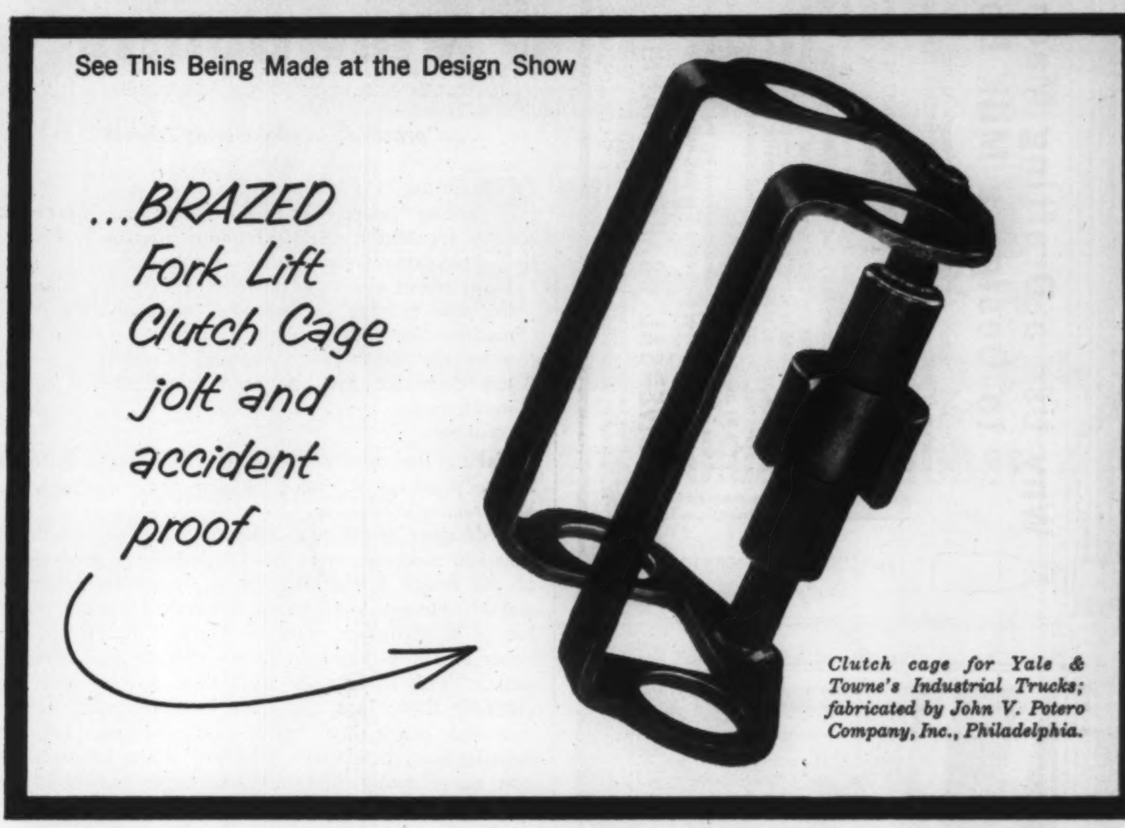
Handy & Harman EASY-FLO 35 So Effective Yale & Towne Redesigns 39 Parts for Silver Brazing



See This Being Made at the Design Show

Clutch cage for Yale & Towne's Industrial Trucks; fabricated by John V. Potero Company, Inc., Philadelphia.

One of the problems in operating a fast-moving, stop, go and back-up fork lift truck is accidental overtravel of gear-shifting from forward to reverse and vice versa. The result, of course, is a useless unit.

This simple clutch cage makes it impossible to jam a fork lift's gear box with resulting time lost for repair. The operator can't make a mistake.

The frame and shaft, of separate pieces, are made of mild steel. The shift lever lock, in the center of the shaft, is made of hardened steel. It is positioned by two tubular sleeves of mild steel. The entire assembly is hand torch-brazed with EASY-FLO 35 and HANDY FLUX with no loss of hardness.

Welding was considered but rejected because of the necessary follow-up of "spatter" cleaning. With simple silver brazing, flux removal is the only finishing operation required. This, plus the fact that silver brazing is much *easier* (your operator need not be a practiced "torchbearer"), has prompted Yale & Towne to redesign thirty-nine of their parts and components so that they can be brazed.

Come see this part being brazed at the Design Engineering Show in Philadelphia, May 25 through 28; at Handy & Harman's Booth 115. Any questions you may have between now and then about silver alloy brazing and the benefits it imparts to thousands of components, parts and assemblies, may be addressed to Handy & Harman, 82 Fulton Street, New York City 38.

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This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

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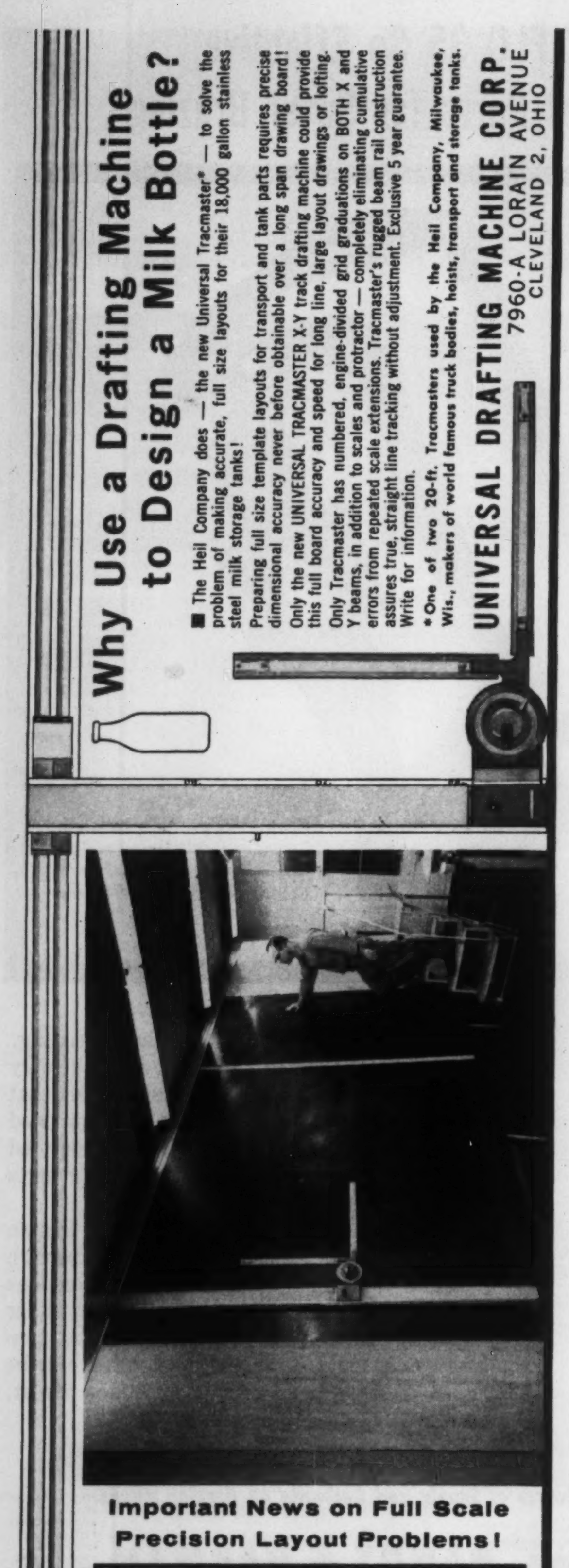

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*One of two 20-ft. Tracmasters used by the Heil Company, Milwaukee, Wis., makers of world famous truck bodies, hoists, transport and storage tanks.

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Professional Viewpoints

. . . *"practice" in engineering schools* . . .

To the Editor:

Regarding "practice" in engineering schools, MACHINE DESIGN for March 19, 1959 quotes Melvin J. Kelley, Bell Telephone Laboratories, as follows:

> Until recent years too much of engineering training was devoted to "practice" and too little to mathematics and science. . . . However, in recent years the amount of "practice" in the curricula has decreased and the amount of science and mathematics increased. This trend . . . should continue.

Taking the opposite view in this matter, I would like to point out the need for elementary shop courses and practice in drafting.

A designer of complex machinery has to be able to visualize mechanisms in his head, have a good share of the design made before a paper representation is started. He can learn to do this only by practice and lots of it. A designer cannot give a draftsman an abstract idea and expect to get an efficient and effective design. This is why our equipment costs so much to engineer these days. Students have been led to believe it is below their dignity to do drafting. This results in fuzzy thinking, for without doing layout work you never really come to grips with the problems involved.

Use of materials to their ultimate capabilities for a given situation, maximum utilization of space to provide maximum rigidity with minimum weight, etc., cannot be efficiently determined, if determined at all, by draftsmen—it is the engineer's responsibility. He can learn to do it only by practice.

In order to use materials efficiently, one has to know the methods of manufacture. In the miniaturized equipment being designed and developed these days, this has to be considered from the first conception of a mechanism. The designer has to know when he can drill a hole, punch it, grind it, broach it, shave it, burnish it, mill it, cast it, etc. It is not economical for him to get such information second or third-hand, after spending hours or days on design, and then have to start over. He can learn these facts only by some shop practice, and he must eventually gain this knowledge some place.

We cannot afford to subsidize this training at industrial rates. The majority of engineers just out of school now cost a given project over six dollars per hour with overhead. We cannot afford to spend that much money to teach men how a drill works, what can be done in a milling machine, and what a grinder does.

Our engineering students require a better foundation

New!

Fibrous Silicone Rubber

- *high permeability*
  - *excellent compression-deflection*
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      - *−65°F to 500°F temperature range*
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The unusual and random orientation of silicone rubber fibers as shown in the background gives COHRlastic FSR good tensile and tear strength, high permeability, very low density, excellent compression-deflection characteristics, extremely good compression set, and a useful temperature range of −65°F to 500°F.

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5/32	3000	2880	5720
3/16	4400	4140	8240
1/4	7700	7360	14720
5/16	11500	11500	22960
3/8	17600	16580	33160
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Circle 664 on Page 19

in the basic sciences and mathematics, but they also need practice in the skills they would use a good share of the time while producing things for their employers.

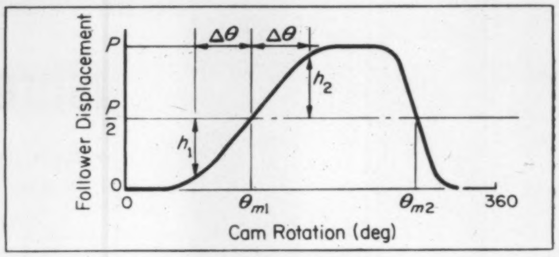
—CHAS. H. BERGSLAND
Mechanical Div., General Mills Inc.
Minneapolis, Minn.

. . . mirror-image cams . . .

To the Editor:

In David C. Allais' article, "Mirror-Image Cams" (MACHINE DESIGN, Jan. 22, 1959), the question of whether this specific application of conjugate cams can be applied to a given motion requirement can be more easily answered affirmatively if the following additional condition exists:

The angle between the midpoints of the rise and fall (θ_{m1} to θ_{m2}, respectively) is 180 degrees.



Proof:

1. If D_1 equals degrees of dwell at minimum displacement and D_2 equals degrees of dwell at maximum displacement:

$$D_1 + \theta_{Rise} + D_2 + \theta_{Fall} = 360 \text{ degrees}$$

2. And, as the prime requirement for mirror-image cams:

$$D_1 = D_2 = D$$

3. Substituting Equation 2 in Equation 1 and dividing by 2:

$$\frac{D}{2} + \frac{\theta_{Rise}}{2} + \frac{D}{2} + \frac{\theta_{Fall}}{2} = \frac{360}{2}$$

4. Then the angle between midpoints of rise and fall is:

$$D + \frac{\theta_{Rise}}{2} + \frac{\theta_{Fall}}{2} = 180 \text{ degrees}$$

—C. PHILIP STRAKOSCH
The de Florez Co. Inc.
Englewood Cliffs, N. J.

To the Editor:

Mr. Strakosch is certainly correct. It is of further interest to note that mirror-image cams are not restricted to the dwell-rise-dwell-fall profile shown.

Such complementary cams have been cut with multiple rises and falls and one or several dwells at the midpoint. Mechanisms which require a resetting action may employ such cams with a midpoint dwell and equal travel in either direction.

—DAVID C. ALLAIS
International Business Machines Corp.
San Jose, Calif.

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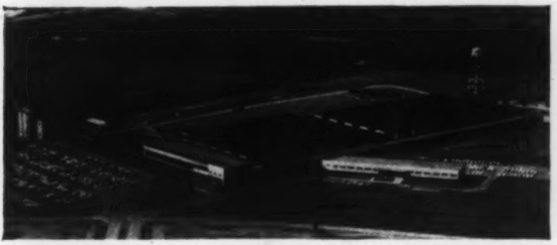

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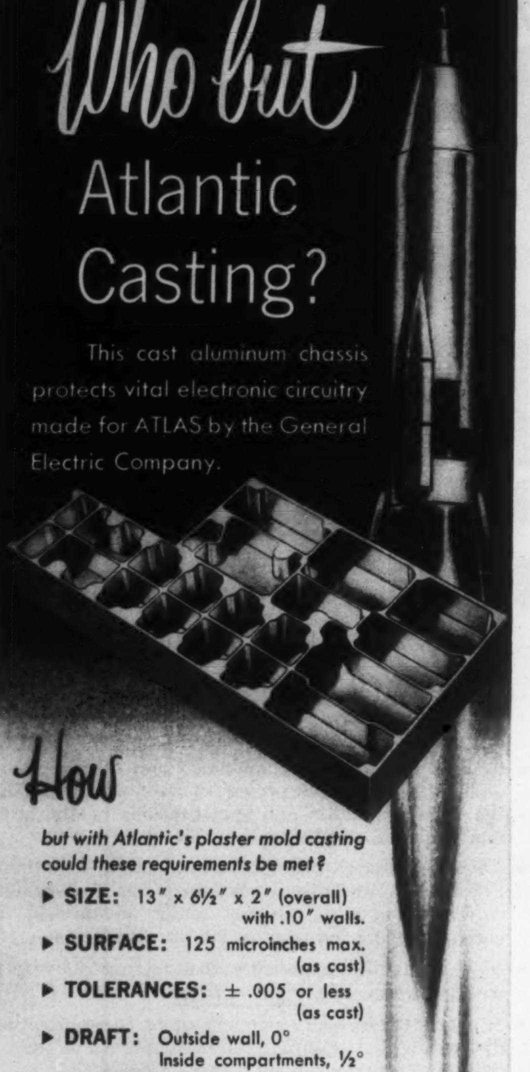
Circle 665 on Page 19

Who but Atlantic Casting?



This cast aluminum chassis protects vital electronic circuitry made for ATLAS by the General Electric Company.

How but with Atlantic's plaster mold casting could these requirements be met?

- **SIZE:** 13″ x 6½″ x 2″ (overall) with .10″ walls.
- **SURFACE:** 125 microinches max. (as cast)
- **TOLERANCES:** ± .005 or less (as cast)
- **DRAFT:** Outside wall, 0° Inside compartments, ½°
- **FLATNESS:** .010 (overall)
- **WITHOUT FLAWS:** (checked by X-Ray)

Tolerances are too close and overall size too large to be economical by investment casting. Surface finish and tolerances are too tight for sand or permanent mold casting.

Quantity is too small and soundness too critical for Die Casting.

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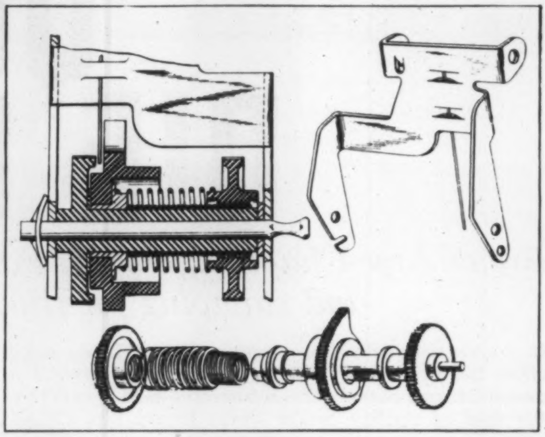
NOTEWORTHY

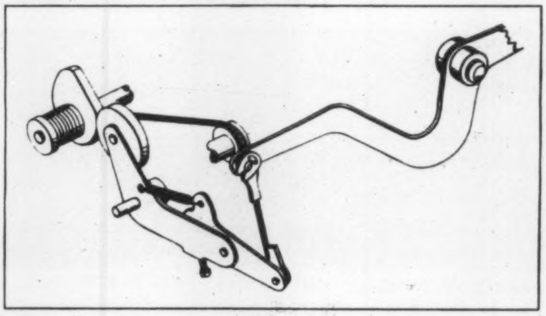
Patents

Automatic Cut-Off Mechanism

A difference in OD of two coaxial friction wheels, both driven by the same powered roller, determines a switching time interval. At the end of this period a cam on the wheel shaft switches off power to the roller. The smaller friction wheel, called a climbing wheel, has a threaded bore larger than a thread on the common shaft. Contact with the roller engages the wheel thread and the shaft thread tangentially, thus traversing the wheel toward the cam. In time, the wheel engages the cam like a plate clutch, and a "flip" cycle of the cam throws a power switch. *Patent* 2,879,877 *assigned to International Business Machines Corp., New York, by Stig B. Tibbling.*



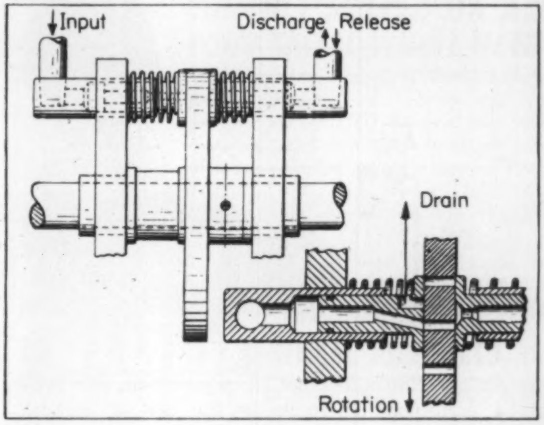
Controlled-Deceleration Drive



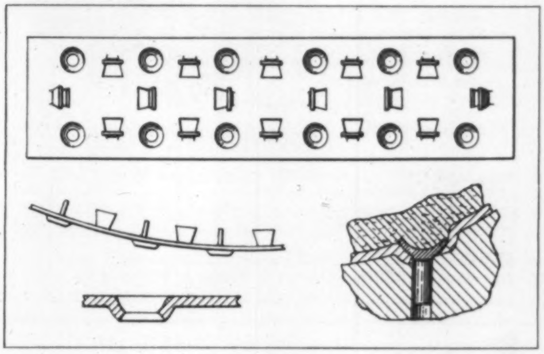
Linear travel of a machine carriage, in one direction, is decelerated and stopped by a control cam attached, through a spring clutch, to a constant-speed power shaft. Controlled travel starts when a linkage engages the carriage. Force that moves the carriage in the control direction is transmitted through the linkage and holds a follower against the cam. At large cam radii, torque tightens the clutch spring so that further motion is a function of camshaft speed. *Patent* 2,879,879 *assigned to International Business Machines Corp., New York, by Ronald D. Dodge.*

Fluid-Pulse Generator

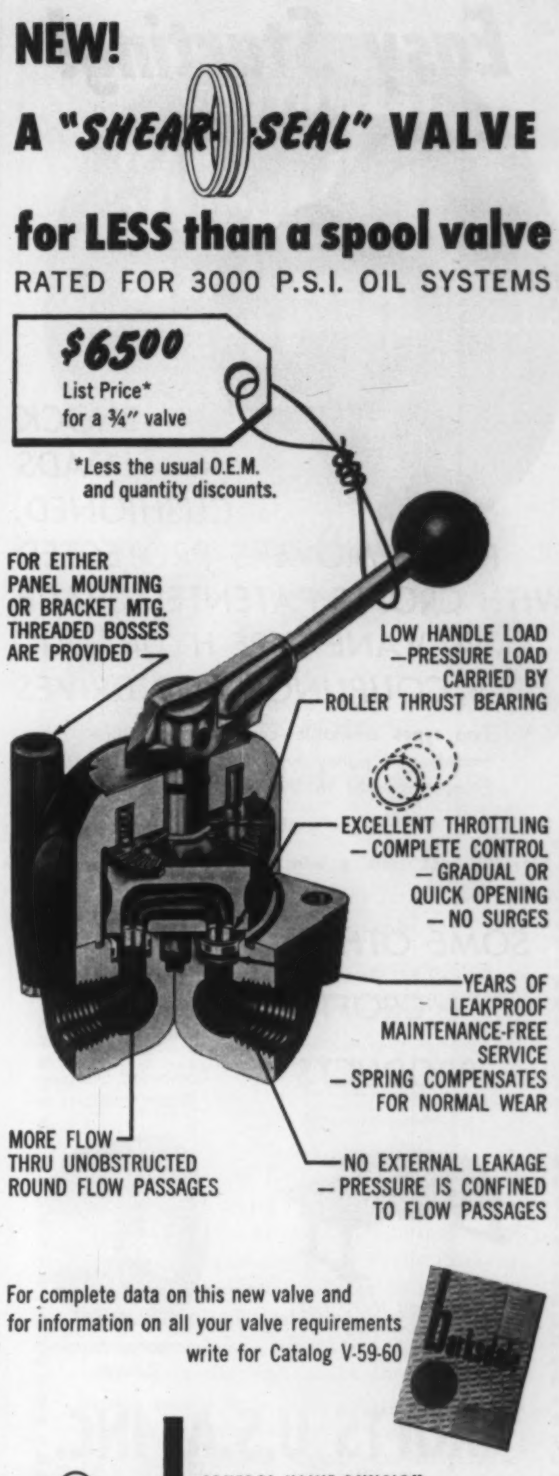
High-frequency fluid impulses are provided by a rotating disc which carries holes, on a common diameter, between a fluid-pressure source and an outlet. The disc slides continually between two stationary fluid-line parts which are forced against the disc by springs to minimize fluid leakage. When output impulses must reciprocate a mechanism, pressure between impulses is relieved as disc holes are aligned with a drain passage. *Patent* 2,879,797 *assigned to Bond Research Laboratories, Somerville, Mass., by Leonard Alexander Guaraldi.*



Molded Brake-Shoe Lining



Expendable rivet plate in a brake shoe assembly enables use of molded friction materials for the wearing surface, and simplifies replacement of worn members carried on a nonexpendable base plate. The friction material is keyed in place by anchor tabs pressed out from the concave surface of the rivet plate. Rivet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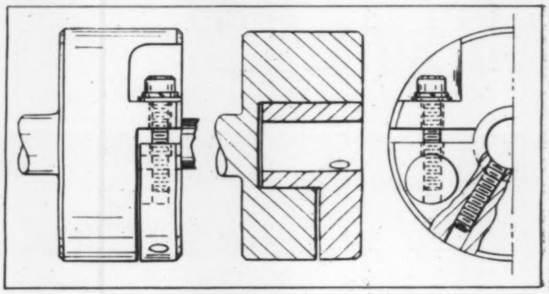
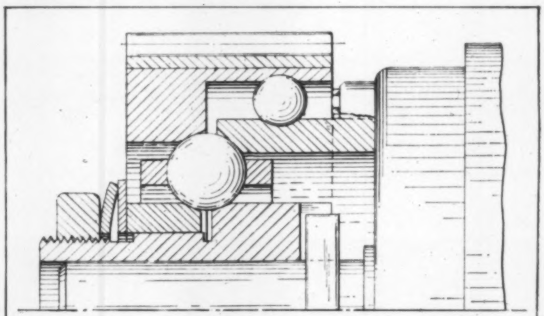
shanks pass through the rivet plate into the base plate. Rivet head seats are spherical to enable all rivet shanks to be parallel, and thus simplify replacement of shoe assemblies. *Patent* 2,879,866 *assigned to Westinghouse Air Brake Co., Wilmerding, Pa., by George K. Newell.*

Adjustable Shaft-Angle Coupling

Clearance between two principal members of a coupling assembly enable angular relationship of two coaxial shafts to be adjusted accurately in a range less than 10 degrees. A collar, fixed to the driven shaft by set screws, is received with close fit in a bore of the driving clutch member. A segment on the collar fits a corresponding recess in the driving member. Substantial clearance between chord surfaces enable two screws, which hold the coupling together, to be turned in and out alternately to adjust angular settings of the shafts. Screws are not bent in this operation because the only threads they engage are in two round plug pivots in the driven collar. *Patent* 2,867,461 *assigned to the United States of America (Air Force) by Stanley Kahn and Nesbit L. Duncan.*



Adjustable-Speed Ball Drive



An adjustable-speed reduction drive uses a ring of balls; continuously loaded, to transmit torque from driving to driven members. Speed-reduction ratios depend on differences between distances from the axis of the drive to points at which balls contact races. Both inner and outer races are made in two parts. One inner race is fixed to the shaft. The other, forced axially by

Circle 668 on Page 19

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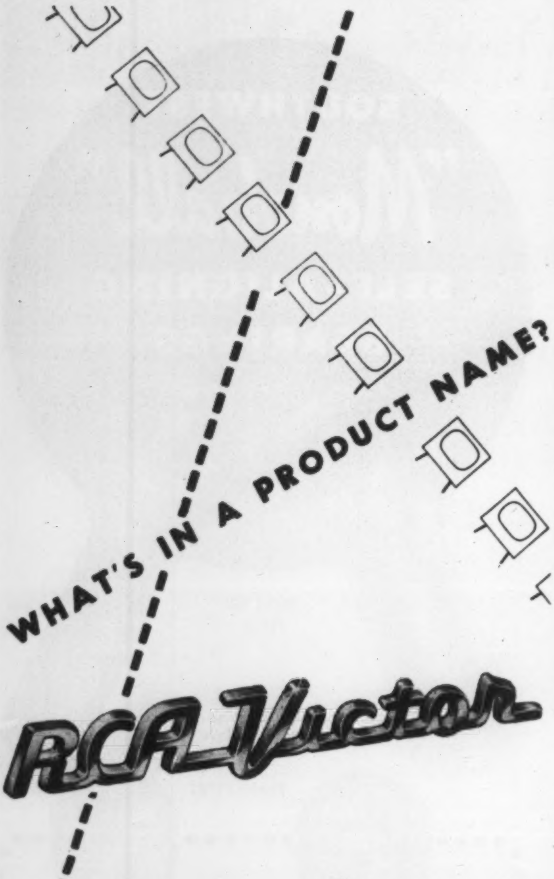
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Circle 672 on Page 19

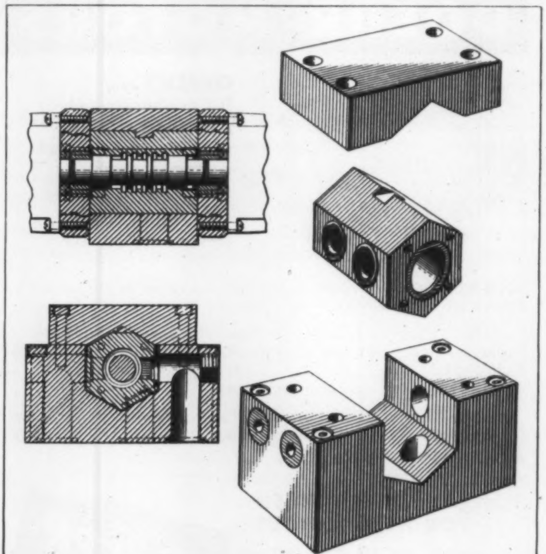
a spring washer, loads the balls. One outer race part is fixed or controlled. The other is integral with a power transmitting member. Both have conical surfaces contacting the balls. Changes in the angles of the cones cause changes in contact radii, hence different speed ratios. A ring of smaller balls simply supports the output member, *Patent* 2,875,646 *assigned to Specialties Inc, Syosset, N. Y., by Louis Bucalo.*

Breakaway valve provides fail-safe connection for pneumatic lines. When the connection is "broken," either accidentally or otherwise, the valve closes automatically to prevent loss of air pressure in the supply line. *Patent* 2,879,081 *assigned to Keehn-O-Mfg. Co. by Warner L. Keehn.*

Crank-operated valve for handling abrasive fluids under high-pressures develops high leverage forces to facilitate opening and closing operations. Crank forces are transmitted to valve gate by an eccentric sliding-block arrangement which provides varying force magnification as crank is rotated. *Patent* 2,873,085 *assigned to Cameron Iron Works Inc., Houston, Texas, by Herbert Allen.*

Manifold Valve Mounting

Simple, angular, geometric shape of a manifold valve mounting expedites removal of both mounting and valve, as a unit, for repair and replacement or immediate substitution. The only hydraulic seals in the assembly are carried by the manifold on the edges of holes which abut corresponding holes in the block. Alignment of the valve mounting in the manifold block



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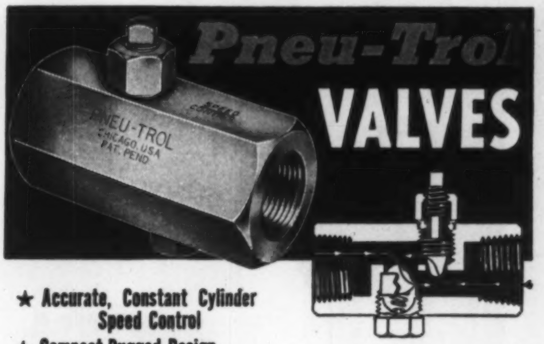
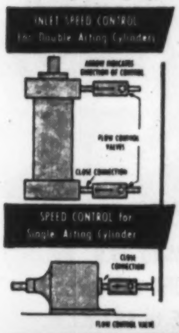
Circle 673 on Page 19

Pneu-Trol VALVES



★ **Accurate, Constant Cylinder Speed Control**
★ **Compact Rugged Design**
★ **Simple, Easy Speed Selection** ★ **For Air, Oil or Water Applications**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FLOW CONTROL VALVES
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Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes – ⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

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A DIVISION OF AUTO-PONENTS, INC.
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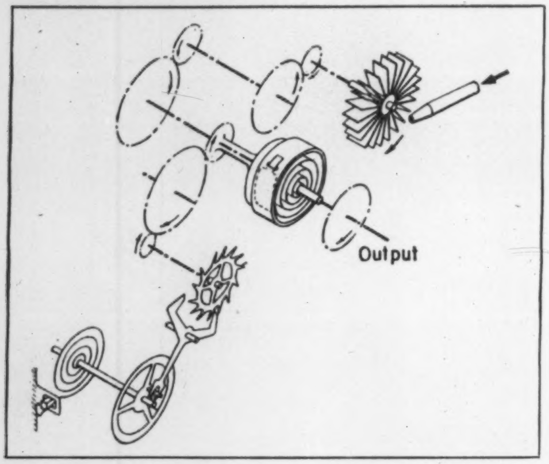
COMMERCIAL MOTOR DIVISION
17626 Broadway • Cleveland 1, Ohio

Circle 675 on Page 19

is provided by a slot on the mounting which engages a key formed integral with the cap of the block. *Patent* 2,879,788 *assigned to Beckett-Harcum Co., Wilmington, Ohio, by Donald E. Beckett and William N. Beckett.*

Constant-Torque-Drive



Uniform torque is delivered continuously by a shaft engaged simultaneously with a source of power and a source of time. The source of time is a conventional mechanical escapement. The source of power is an air nozzle driving a simple turbine. Both sources engage the output shaft through gear trains. Torque fluctuations, caused by variations in the air stream, are damped by a coil spring on the output shaft. *Patent* 2,877,669 *assigned to Bailey Meter Co., Cleveland, by Jack F. Shannon.*

Hydraulic linear actuator has built-in mechanical brake which arrests movement of actuator rod in one direction of travel when fluid pressure fails or loads become abnormal. Brake is released by fluid pressure and remains disengaged as long as normal operating conditions prevail. *Patent* 2,879,746 *assigned to General Motors Corp., Detroit, by Howard M. Geyer, Norman J. Bullock, and James W. Light.*

Small-shaft flexible coupling consists of one flanged hub. Shaft with opposing flat surfaces is inserted between spring pins in one bore opening. Spring-action of pins holds shaft in place, accommodates misalignment, and minimizes backlash. Other bore of coupling is attached rigidly to second shaft with set screw. *Patent* 2,875,598 *assigned to Bendix Aviation Corp., Towson, Md., by Theodore L. Knight and William J. Bichell.*

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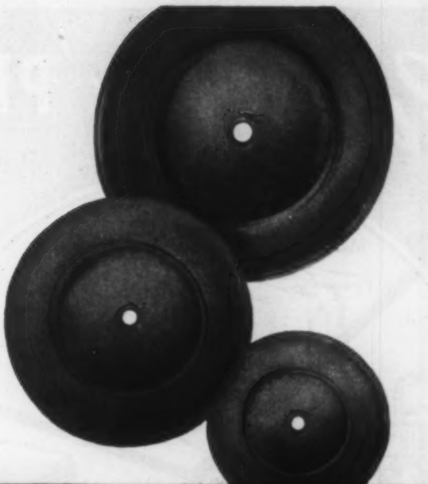

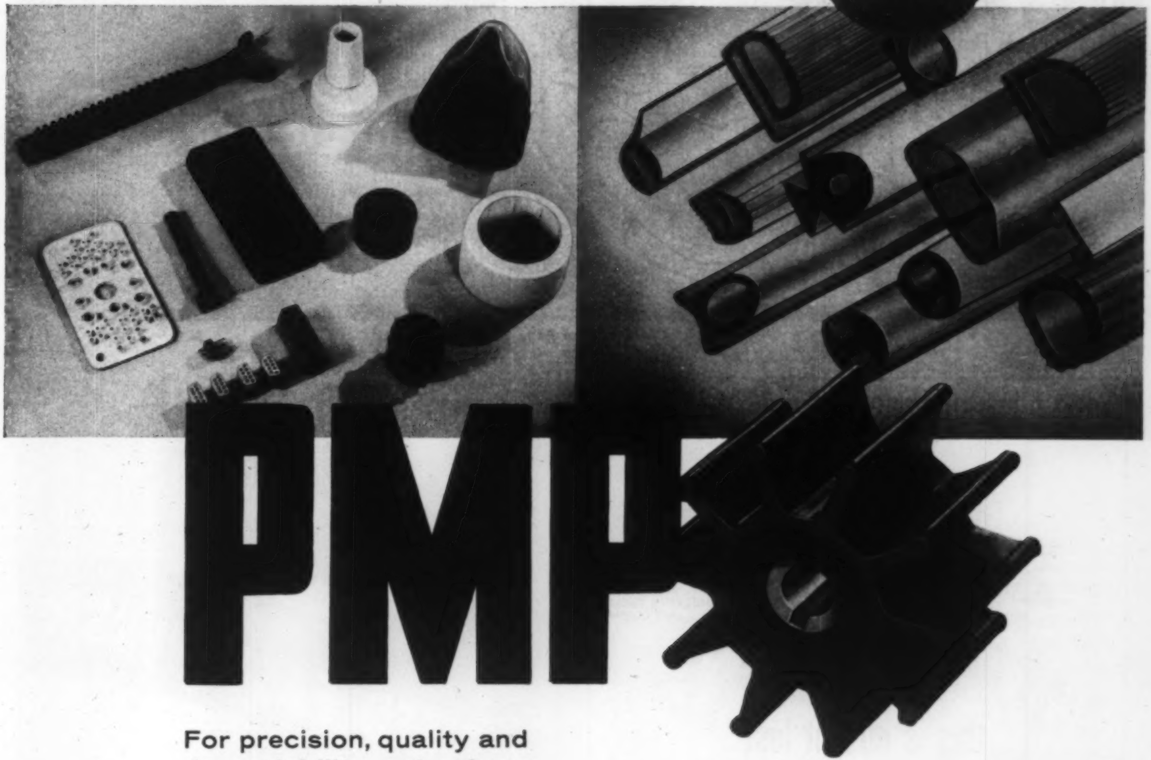

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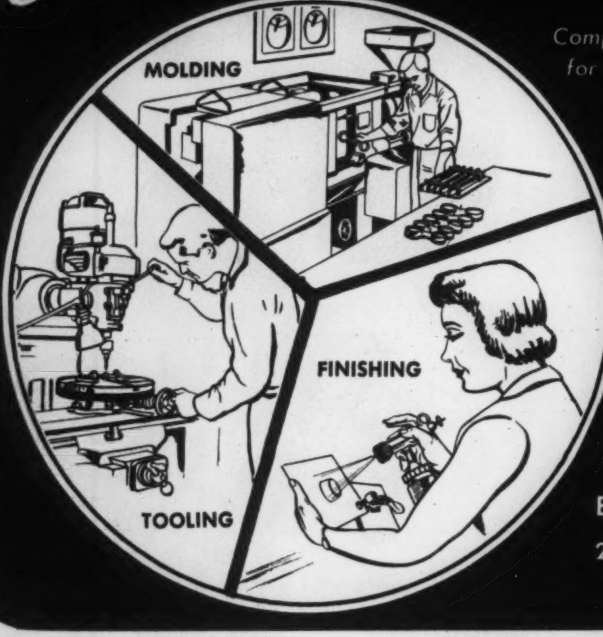

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AIR VALVES
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Life Saver size - only 7/16" x 3/4"

Tinymite Coupling Actual Size

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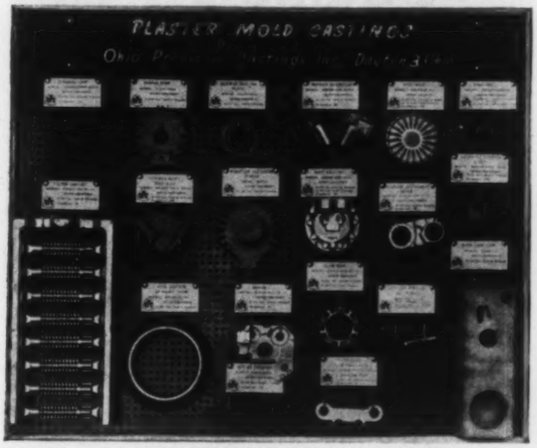

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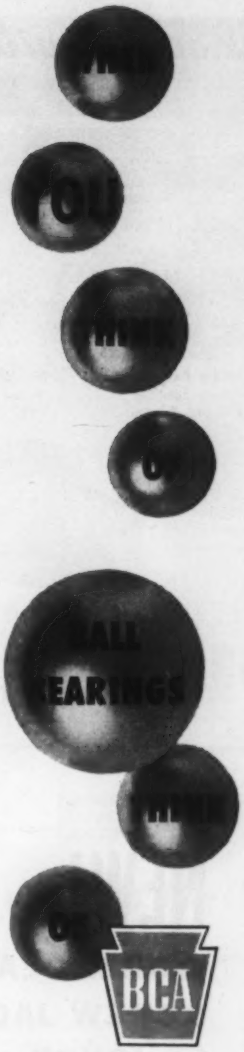

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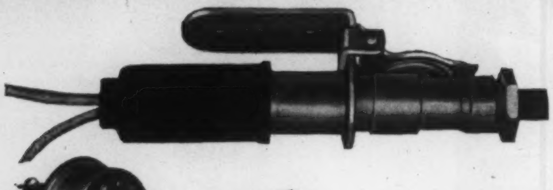
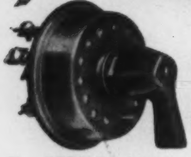
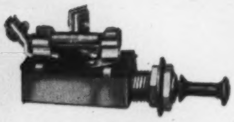
COLE-HERSEE *Switches & Connectors*



No. 1281 Heavy Duty Polarized Two Pole Electrical Connector (Insulated or Grounded)

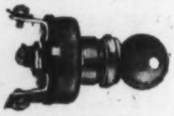


No. 9524 Combination Rotary Ignition & Light Switch

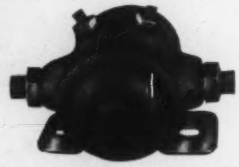


No. 5053 Push Pull Fused Light Switch

No. DL-5 Dash Lamp



No. 9522 Key Operated Ignition & Light Switch



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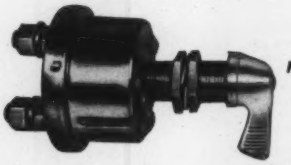

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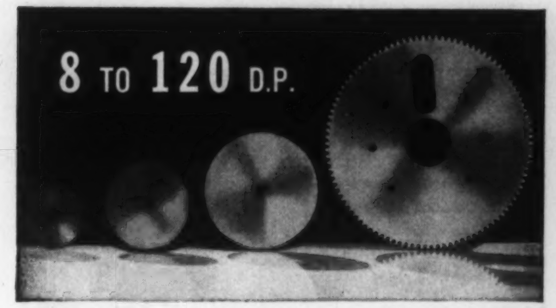

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GENERATORS —1 KW; 2½ KW,
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- Basic Designs
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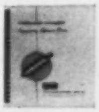

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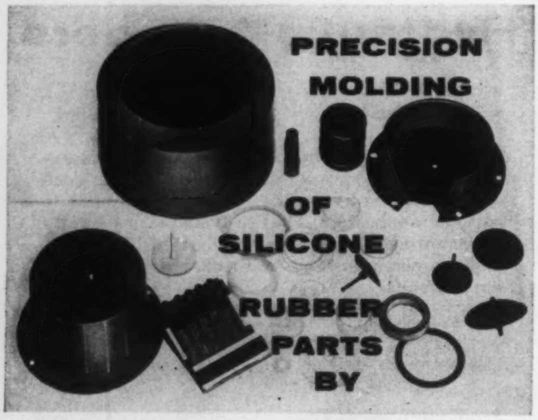

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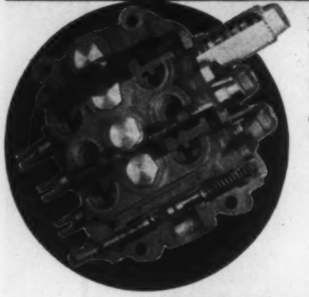

HUSCO Multi-Plunger Hydraulic Control Valves, in basic design, or custom-engineered adaptations, provide quick solution to your equipment control needs. Check these features:
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Enclosed Gearmotor for Vending and Similar Applications

- Speed Range 420 to 1 RPM
- Power range minimum to 40 in. lb.
- Quiet motion—dependable power—service free
- Totally enclosed and lubricated for life
- Compact rigid construction and minimum space
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- Prompt delivery
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Designers and Manufacturers of
SPECIAL ELECTRICAL EQUIPMENT

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TORQUE
applied by the inch ounce

ACTUAL SIZE
sent on request

Available in these Torque Ranges

MODEL	CAPACITY
F80-I-G	0- 80 inch grams
F8-I-O	0- 8 inch ounces
F16-I-O	0- 16 inch ounces
F32-I-O	0- 32 inch ounces
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F160-I-O	0-160 inch ounces

Inch pound models and larger foot pound ranges also available

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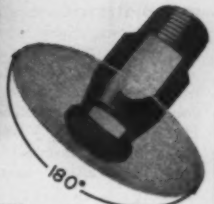
New Nozzles

*SPAN-JET
FLAT SPRAY NOZZLES



For spraying or washing inside of tubular units or other uses where a circular wide-angle spray is needed. Made in two patterns — 160° hollow-cone spray or 180° flat-circular spray. Available in brass or 303 stainless steel — others on request. Sizes ⅛" — ¼" — ⅜" male conn.

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SOLID CONE NOZZLES

Non-clogging nozzles having a uniform solid-cone spray pattern, furnished in brass, steel, 303 stainless or other suitable materials for any application or process which involves spraying of fluids. Sizes ¼" — ⅜" — ½" male or female conn.

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- New Spray Nozzles for various applications.
- Large selection of spray angles and capacities.
- Simplified, time-saving nozzle selection tables.

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SERVING INDUSTRY FOR MORE THAN FIFTY YEARS

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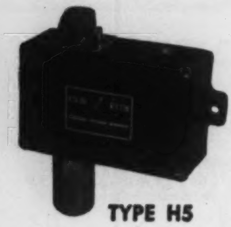
External Adjustment & Calibration
on
PRESSURE & VACUUM CONTROLS **H5** **H12**


TYPE H5

TYPE H12

UNITED ELECTRIC designed these controls for industrial applications where outside adjustment and calibration are important factors. Types H5 and H12 accurately and sensitively control liquid level alarms and air gas pressures. The type H5 (minimum 2 psi differential) controls up to a maximum of 500 psi, and the type H12 (minimum 3" wc differential) up to 180 psi. Uncalibrated, internally adjusted versions of these controls are available as type J7 and type J6 respectively.

Switch Differential	H5 — Uniform on-off differential, fixed from 2 psi to 30 psi. H12 — Uniform on-off differential, fixed from 3" wc to 2 psi.
Switch Ratings	15 amps. at 115 or 230 volts AC, also 20 amps. or DC switches on specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size & Weight	H5 — 5⅛" x 4⅞" x 1½" . . . weighs approx. 1 lb. H12 — ¾" x 2¾" x 5" weighs approx. 1 lb. 6 oz.
Electrical Connection	Conduit opening in enclosure — ⅞" O.D. Internally-located terminal block.
Enclosure	Die-cast aluminum case with black wrinkle finish.
Mounting	H5 — Directly, by ¼" female NPT on bellows housing; or surface mounted by mounting ears on each end of case. H12 — Directly, by ¼" female NPT on bellows housing.
Bellows	H5 — Spring loaded, seamless brass, stainless steel or monel. H12 — Spring loaded, seamless brass bellows.
Pressure Connections	¼" female NPT.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. UE will gladly modify or custom-build a unit to meet your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 5-5 for complete H5 data and Bulletin No. 5-2 for complete H12 data.

U.E.
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COMPANY
SCHOOL STREET WATERTOWN MASS

Circle 697 on Page 19

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DESIGN MANUAL
NO. 401G
(Illustrated in color)

20 pages

standard instrument cases

- ✓ 120 STANDARD TYPES AND SIZES
- ✓ FREE VELLUM SERVICE
- ✓ THREE WEEK DELIVERY 1ST ARTICLE
- ✓ STANDARD INSTRUMENT PANELS
- ✓ ALL ALUMINUM CONSTRUCTION
- ✓ SUBMERGENCE-PROOF TO MIL-STD-108C
- ✓ CONSTRUCTED TO MIL-T-945A
- ✓ COMPLETE DESIGN INFORMATION

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Circle 698 on Page 19

Precise-Uniform

Gillen TAPER PINS
¼" per foot

TRUE TO TAPER

- **For Precision Assembling**
- **Available in All Metals**
- **Complete Range of Sizes**
- **Rust Resistant Coating**
- **Standard Turned Pins**
- **Centerless Ground Pins**
- **Threaded End Pins**
- **Immediate Delivery**

Diameters From 7/0 to No. 14
•
Up to 13" Lengths
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New Threaded End Pin Has Many Uses for Blind Hole Assemblies

Taper Pins
•
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•
Machine Keys
•
Woodruff Keys

John Gillen Company
Keying and Pinning Devices
2568 South 50th Avenue • Cicero 50, Illinois
A Subsidiary of Standard Railway Equipment Manufacturing Company

Circle 699 on Page 19

when it's a
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GASKETS
PACKINGS
WASHERS
SHIMS, SEALS
BUSHINGS
"O" RINGS
the ANSWER
will be found
at AUBURN...
We fabricate
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Minneapolis, Minn.; Pittsburgh, Pa.; Cincinnati, Ohio; Ridgewood, N. J.;
Atlanta, Ga.; Memphis, Tenn.; St. Louis, Mo.; Washington, D. C.

Circle 700 on Page 19

A FUNK TRANSMISSION MADE THE DIFFERENCE HERE...

On this Bucyrus-Erie Hydrocrane, a FUNK-designed transmission drives three hydraulic pumps at the same time.

Placed between the engine and the pumps, FUNK's compactly-built transmission saves space by taking only a fraction of the room needed for chains and belts. Saves on cost, too. Requires less service and is much safer.

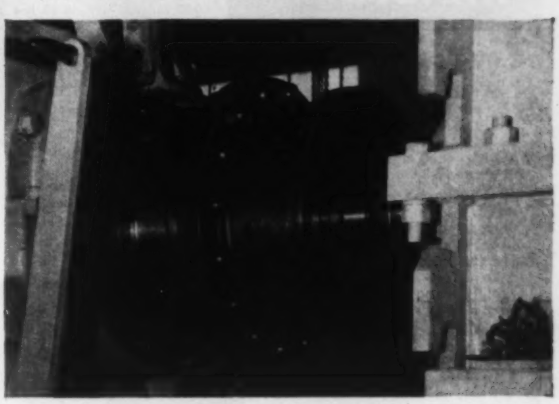
Another example of how FUNK MODULAR POWER UNITS can be combined in an unlimited number of arrangements — *without* expensive engineering costs.

Let FUNK solve *your* power transmission problem.

FUNK MFG. CO. Box 577-F, Coffeyville, Kan.

Circle 701 on Page 19

AT WALDRON...
Specials
ARE STANDARD AND VICE-VERSA



In the picture above is a Waldron #8 Cut-Out Coupling. It couples the power to a shearing machine, which takes mild steel strip from coil, straightens it and cuts it to lengths between 3' and 24' at the rate of 1250 feet per minute.

This is a Waldron "special" because it was developed for a particular application. Waldron engineers put a lot of know-how into producing this unit, but with their knowledge acquired through years of experience in dealing with many similar power transmission problems, it became a simple task.

On the other hand, "standard" couplings receive so much attention in production, that they run as if specially designed for the application. Waldron believes that the coupling is as important as the driver and the driven and so should receive the same fine forgings, machining and assembly as the equipment it couples.

If you are in the market for couplings, either specials or standards, speak to the engineers at Waldron. In both cases you will be assured of the highest quality possible.

JOHN **WALDRON** CORPORATION
Subsidiary of Midland-Ross Corporation
NEW BRUNSWICK, NEW JERSEY

Circle 702 on Page 19

fractional horsepower at its finest!

RAE motors

Rae M-12 or M-13 with G-12 reducer. M-12 and M-13 motors AC/DC Universal or Shunt. 1/5 H. P. Max. G-12 gear unit 536:1 Max. and 100 in. lbs. Max. M-13 has ball bearings.

choice of leading manufacturers

Don't gamble with the success of your product! By careful analysis and testing together with RAE engineers you can assure the right motor for your needs.

RAE offers outstanding service and quality in a large variety of motors in voltages up to 250, and up to 1/8 H.P. (higher for intermittent duty) with many gearhead motor combinations. Let us show you how these advanced motors, now in such big demand, can *improve your product* and *reduce your costs.*

- AC/DC Universal
- DC Shunt Wound
- DC Series Wound
- DC Compound Wound
- Gear Reduction Motors
- Governor Controlled Motors
- Motors for Rheostat Control
- Motors for Electronic Control
- Permanent Magnet Motors and Gearmotors

Send for the "RAE" service sheet. It will help you supply the data necessary for recommendations and prices.

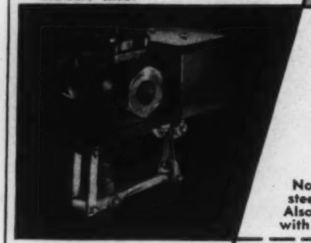
Rae MOTOR CORP.
2009 Kewaunee Street
Racine, Wisconsin

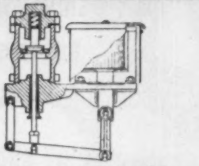
Circle 703 on Page 19

BIG LINE-UP BIG PERFORMANCE

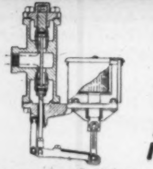
Johnson Solenoid Valves are built for heavy duty service . . . handling, air, water, steam, heavy viscous liquids. No pilots or pistons; powerful leverage design opens smaller valves against 250 lbs. Because of the remoteness of the solenoid, temperatures up to 400° F. are easily handled without adverse effect on the solenoid coil. Bodies are bolted together. Explosion-proof models also.

JOHNSON Direct Operated SOLENOID VALVES

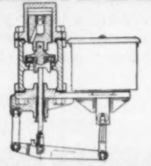




Normally closed service, stainless steel valve and seat. Sizes 3/8"-3". Also for normally open service, and with Jenkins Disc.



3-way valve. Stainless steel valves and seats. Sizes 1/2"-1 1/2".



Dashpot construction, cushions closing to avoid water hammer. Jenkins Disc. Sizes 3/4"-2".

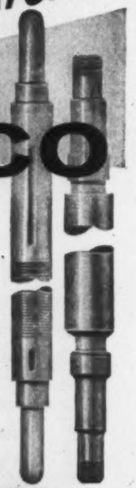
Write for Bulletin "V"

THE JOHNSON CORPORATION
811 Wood St., Three Rivers, Mich.

Circle 704 on Page 19

If it's CYLINDRICAL – consult PAMARCO

PRECISION COMPONENTS FOR REPLACEMENT AND PRODUCTION



Pamarco offers complete service on light or heavy duty precision cylindrical components. Large quantities for production or parts for maintenance. Rolls, shafts, axles and other cylindrical parts to closest tolerances. Chrome, copper and pentrate finishing, slab milling, long keyways. Eliminate production bottlenecks with Pamarco high-accuracy cylindrical parts!

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PAMARCO INCORPORATED
ROSELLE, NEW JERSEY
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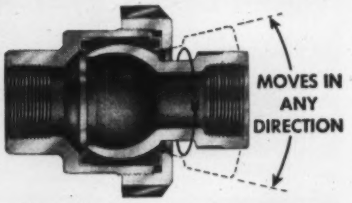
PRECISION CYLINDRICAL PARTS · ROLLS FOR PRINTING, CONVERTING, GENERAL INDUSTRIAL SERVICE

Circle 705 on Page 19

BARCO *Flexible* BALL JOINTS

—when you need movable joints in piping handling



STEAM, OIL, CHEMICALS

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- Provides for movement in piping—up to 40° side flexibility, plus 360° rotating movement.
- Stainless steel and chemically inert gaskets for strong chemicals. No metal-to-metal contact. Choice of body materials.
- One Barco Ball Joint does the work of two or more ordinary swivel joints because "it moves in any direction!"
- Many models available. For pressures to 4,500 psi; temperatures to 1000°F. 15 different sizes. 1/4" to 12". *Ask for recommendations.* BARCO MFG. CO., **506F** Hough St., Barrington, Illinois.

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING AND REVOLVING JOINTS

Circle 706 on Page 19

To the Designer Who Wants Sharper Prints

DAMASCUS

does the job better

Make this test. Compare the **prints** from drawings made by your present pencil and Damascus Drawing. Look for broken lines, light spots, uneven line edges. You will agree that Damascus gives you sharper, blacker **prints**—as **good as your drawings.** Reproduces beautifully on **MYLAR**.

Send for free sample kit of Damascus Drawing pencils. Or ask the man who knows—**Your Blueprinter.**

RB Richard Best Pencil Company

Springfield, New Jersey

Circle 707 on Page 19

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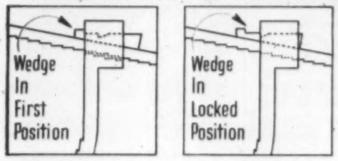
new! Weckesser nylon

Wedge Lock

BAND CLAMP

Patent Pending

TWO-POSITION WEDGE PERMITS ADJUSTMENT FOR TEMPORARY ASSEMBLY . . .



BUT . . . ONCE IT'S LOCKED, YOU'VE GOT TO CUT IT LOOSE!

● Another Weckesser "first" ● Just introduced at the I.R.E. Show ● First *practical* band clamp that locks and holds permanently ● Solid DuPont Zytel 101 (Nylon) ● Easy assembly with screwdriver or forked tool—One size for cable diameters ⅛" to 1¾"

Send for free samples and bulletin

See it at the Design Engineering Show,
Booth 1633, Philadelphia, May 25-28

Weckesser COMPANY

5715 Northwest Highway • Chicago 46, Ill.

Circle 708 on Page 19

IDEA! "I specified it for non-slip treads on our new step-stool line!"
IDEA! "We're installing it on our cruiser line!"

Designers are talking about "SCOTCH-TRED"... stimulating new IDEA material for more creative product design

FUNCTIONAL! Textured "SCOTCH-TRED" surface has high capabilities in slip and skid elimination. Resilient under pressure . . . extra long-wearing . . . non-sparking. *Decorative!* Modern soft colors—beige, gray, black—harmonize with any scheme. *Versatile!* "SCOTCH-TRED" conforms smoothly to almost any surface; can be cut with scissors, knife, or die; pressure-sensitive adhesive sticks at a touch. "SCOTCH-TRED" comes in 9" squares and in 96-foot rolls, in any width up to 36". See Sweet's Product Design File insert 4b/Mi.

scotch • tred BRAND Resilient NON-SLIP SURFACING

"SCOTCH-TRED" non-slip surfacing is made in U.S.A. by 3M Co., St. Paul 6, Minn. Export: 99 Park Ave., New York 16. Canada: London, Ontario.

MINNESOTA MINING AND MANUFACTURING COMPANY 3M
. . . WHERE RESEARCH IS THE KEY TO TOMORROW

CLIP and MAIL for FREE SAMPLE

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St. Paul 6, Minn.

Please rush free sample of "SCOTCH-TRED".

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Firm__________

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Circle 709 on Page 19

MAYLINE

A Choice of Files In Wood or Steel with Mayline

WOOD PLAN FILE

Mayline wood files can be used either as files or as drawer units on Mayline wood 4-Post tables. Drawers will take papers thru 32" x 42". Finished golden Oak.

Mayline metal plan files hold papers thru 36" x 48". Drawers run quietly, easily, on ball bearing rollers. Mayline's exclusive hinged dust cover in all drawers. Choice of finish in Hammertone gray or Olive green.

SEND FOR CATALOG 10

MAYLINE CO., INC.
601 No. Commerce St.
Sheboygan, Wisconsin

PLAN FILE WITH HINGED COVER

MAYLINE

MAYLINE

MAYLINE

Circle 710 on Page 19

THIS BOOKLET "FLOW INDICATING DEVICES" IS YOURS

BOWSER
FLOW INDICATING DEVICES
SHOW WHAT GOES ON IN THE PIPE LINE

. . . CONTAINS DATA ON WIDE SELECTION OF FLOW DEVICES SUCH AS:

Fig. 54A
Flow Sight

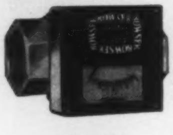


Fig. 816
Teleflo Indicator

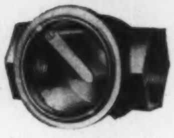


Fig. 811
Flow Indicator

Plant and product engineers have relied on Bowser, liquid handling specialists since 1885, for prompt service. For sight glasses in single or double-window types, gravity or pressure models; or for electric or mechanical indicators . . . and a full line of sight feed oilers.

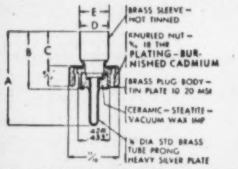
PRODUCT OF BOWSER RESEARCH

WRITE FOR FLOW DEVICES BOOKLET — *Contains Complete Specifications*

BOWSER, INC., MARKETING DIVISION, FT. WAYNE, IND.

Circle 711 on Page 19

Ideal for
ANTENNA CONNECTIONS
PHOTO-CELL WORK
MICROPHONE CONNECTIONS


E
D
A
B
C
BRASS SLEEVE — NOT TINNED
KNURLED NUT — 18 THR PLATING - BURNISHED CADMIUM
BRASS PLUG BODY — TIN PLATE 10 20 MSI
CERAMIC — STEATITE — VACUUM WAX IMP
.420 .432
DIA STD BRASS TUBE PRONG HEAVY SILVER PLATE

SUPPLIED IN 1 & 2 CONTACT TYPES

JONES SHIELDED TYPE PLUGS & SOCKETS

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS

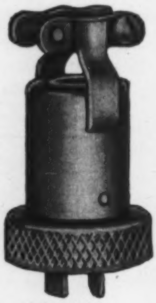
For quality construction thruout, and fine finish, see diagram above.

101 Series furnished with ¼", .290", 5/16", ⅜", or ½" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation; sockets bakelite. Assembly meets Navy specifications.

202 Series Phosphor bronze knife-switch type socket contacts engage both sides of flat plug contacts—double contact area. Plugs and sockets have molded bakelite insulation.

For full details and engineering data ask for Jones Catalog No. 22

P-101-¼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S-101

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JONES MEANS *PROVEN* QUALITY

Jones
HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24 ILLINOIS
DIVISION OF UNITED CARR FASTENER CORP.

Circle 712 on Page 19

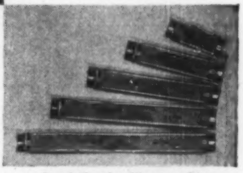
New POWER RESISTORS for FLIGHT USE

ELECTRO-FLEX

specialists in HEATING ELEMENTS

LESS SPACE—LESS WEIGHT

New lightweight, space-saving resistors permit substantial efficiencies and economies in aircraft and missile electronic apparatus. Units are mounted in direct contact with inner surface of chassis or case so that 25% to 40% of heat generated is emitted to atmosphere. Derating curves are available.



Available in the following ratings and sizes

Power Rating	Envelope Dimensions	Approx. Weight
40 Watts	7/32 x 1 5/16 x 4	.027 lbs. ea.
80 Watts	7/32 x 1 5/16 x 6	.040 lbs. ea.
120 Watts	7/32 x 1 5/16 x 8	.053 lbs. ea.
160 Watts	7/32 x 1 5/16 x 10	.067 lbs. ea.
200 Watts	7/32 x 1 5/16 x 12	.080 lbs. ea.

Insulation is silicone rubber— operable continuously at 450° F.
Mounting metal— Alclad aluminum.
Connection tabs— silver plated brass.

Special washers permit bolt or rivet mounting. Adhesive supplied provides good thermal transfer from resistor to mounting wall.

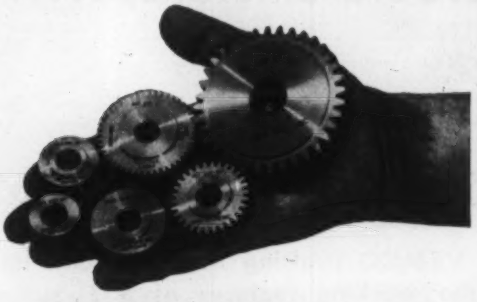
send for free illustrated booklet

Electro-Flex Heat, INC.
83 WOODBINE ST., HARTFORD, CONN. (CHapel 6-5413)

"FIRST with STANDARD ELEMENTS"

Circle 713 on Page 19

MASTER SPUR GEARS
ULTRA-HIGH PRECISION



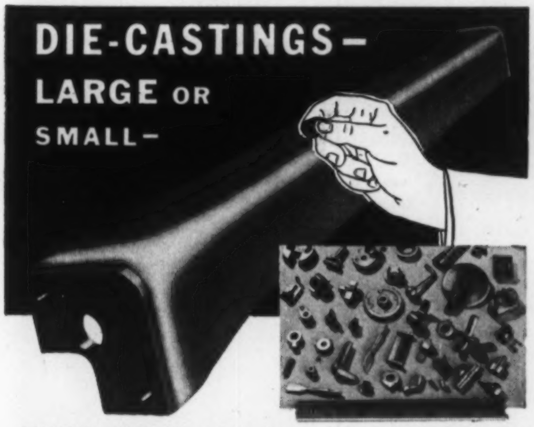
immediate delivery **from stock**

.0002 Maximum Composite Error
20 Pitch and Finer
14½° and 20° Pressure Angles
Hardened and Ground Tool Steel

Quick Delivery on Non-stock Items

(Send for stock list)
INVO SPLINE, INC.
P. O. BOX 25, HAZEL PARK, MICH.

Circle 714 on Page 19



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LARGE OR
SMALL—

DOLLIN Specialized equipment gets the most out of each!

Large Castings. Aluminum castings made on large cold chamber type high-pressure machines. Large zinc castings made on large plunger type machines.

Small Zinc Castings, 1000 per lb. to 3 per lb., made on fully-automatic, high-speed machines. More design latitude — high accuracy — lower tool and piece costs.

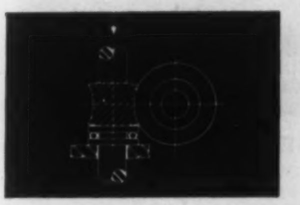
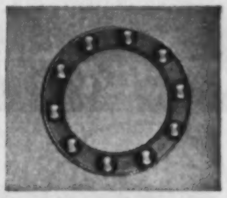
DOLLIN has the most modern, high-speed die-casting machines of every type and size, to produce parts from the largest commercial sizes down to fractions of an inch. This specially-designed equipment, with Dollin engineering, die-making, foundry and machining facilities, offers you the ideal source for high-volume, high-quality die-castings, at the lowest cost.

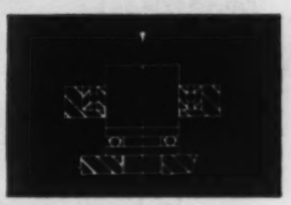
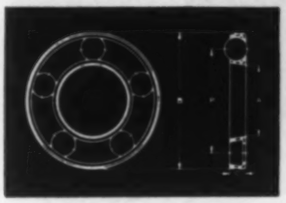
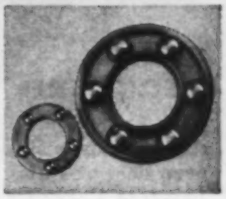
DOLLIN
Zinc and Aluminum
DIE-CASTINGS

● Get the most out of your die-casting designs by consulting Dollin engineers. Submit prints or samples for engineering advice or quotation.

DOLLIN CORPORATION
612 So. 21st St.
Irvington 11, N. J.

Circle 715 on Page 19

Let Low Cost Hartford
BALL RETAINERS
carry the THRUST load

Design engineers in many fields depend on Hartford Ball Retainers to carry thrust loads with precision, and dependability at low cost. Hartford Thrust Retainers are preferred for their superior channel design that provides lightweight, positive ball retention and ball envelopment. They possess exceptional strength. Low contact friction between balls and retainer assures extremely long trouble-free service. Supplied with Hartford precision quality balls of materials to your product requirements, they offer many advantages over shouldered bushings —notably—extremely low starting and operating friction, ease of lubrication, and increased thrust capacity.

Every design engineer should have this handy guide to thrust retainer applications, sizes and capacities. Your copy will be mailed promptly on request.

Hartford
PRECISION THRUST RETAINERS

Hartford Steel Ball Co., Inc.,
95 Jefferson Avenue, W. Hartford 6, Conn.

Circle 716 on Page 19

From PRECISION GEARS To ACCURATE SPEED REDUCERS

Abart Meets Any Industrial Need

GEARS—any type . . . any material . . . custom cut to specifications. Send B/P or specs for sample. Request bulletin.

SPEED REDUCERS

Over 75 types and sizes . . . fractional to over 400 hp., ratios to 10,000 to 1. Ask for information packed catalog.

Prompt Quotations • Quick Delivery • Write Today!

ABART GEAR and MACHINE CO.

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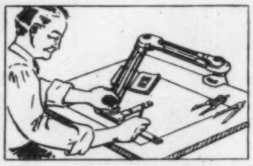
Circle 717 on Page 19

when you know **VEMCO** there's a difference . . . . . .

Before



After

The VEMCO Drafting Machine combines all the working features of a T-square, protractor, and various scales and triangles

Speed and efficiency are lost in the shuffle, when you have to fuss and fumble over a drawing board that's cluttered up with equipment. The modern solution to that is the VEMCO Drafting Machine, which combines the working features of several pieces of drafting equipment. See your VEMCO dealer, and you'll see what a happy difference the VEMCO Drafting Machine can make in your work.

Write today for free illustrated brochure.

VEMCO

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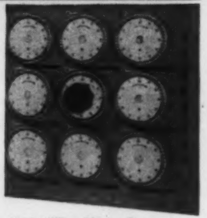
Drafting Equipment of Quality

Circle 718 on Page 19

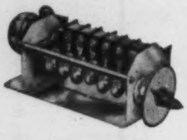
NOW . . . A New Design Concept in Multi-Circuit Program Control

ZENITH Multi-Circuit TIMERS



Model WD—Master Programmer

Master programming dials control operation of all circuits and sequencing relationship between circuits in the cycle. Adjustments are easily made on the face of the panel. As many as 48 "on" and "off" operations can be made on any one circuit without disturbing operation of other circuits. Single heavy-duty motor drives entire unit to assure full synchronization of operations and dials.



Model WM—Compact Design

Zenith Multi-Circuit Cycle Timers are available in models and types for all timing, mixing, compounding, processing and similar operations. They can be supplied in any time cycle and any number of switches.

Request details on the Zenith Master Programmer and other multi-circuit timers. Write on company letterhead for complete 64-page catalog describing automatic transfer and remote control switches, magnetic contactors, program clocks and timing controls.

See Classified Directory for Name of Local Representative

ZENITH ELECTRIC CO.

149 WEST WALTON STREET • CHICAGO 10, ILLINOIS

Circle 719 on Page 19

Stearns miniature electro-magnet disc **BRAKE**

Style "SC" — Size No. 2

SHOWN ACTUAL SIZE

Any-position Operation
Stationary Field
Plug-in Connections
Stub Shaft Mounting
Single-Coil Magnet
"Fail-Safe," Spring-Closed Type

Max. Torque Rating—25 oz.-in. Weight—8.64 oz.
Voltage Rating — 28VDC (4.9 Watts)

For Superior Performance . . . Specify Stearns!

For complete miniature data request
Bulletin No. 504-F
Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN

Circle 720 on Page 19

STAINLESS INJECTION CYLINDER
Nine holes 8" long, for cartridge heaters and plunger, with a microfinish under 60 RMS.

ALUMINUM HYDRAULIC MANIFOLD
36" x 12" x 2½". Six ¼" diameter holes 36" long intersect 36 vertical holes for mounting valves and fittings.

We Gun Drill Parts like these

ALUMINUM VALVE BODY
Three spool holes, held to .0003", drilled from the solid through 13 cross holes. Microfinish under 5 RMS without reaming, broaching or burnishing.

17½" STEPPED HOLE AMS 6407 ROD
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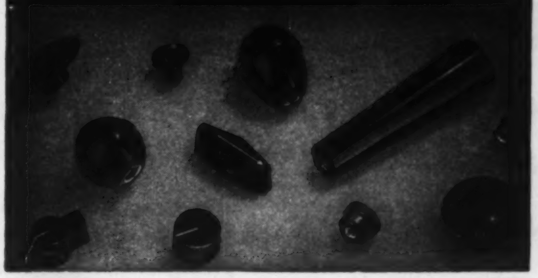

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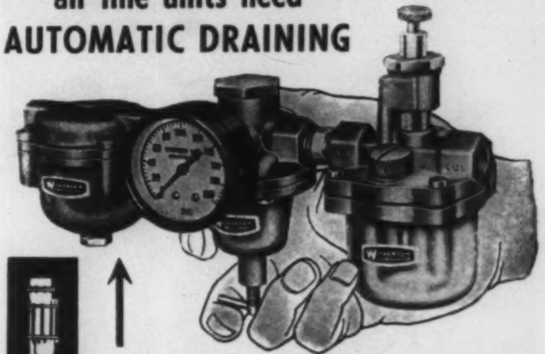

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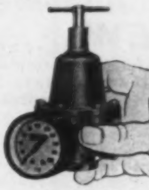

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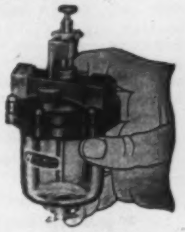

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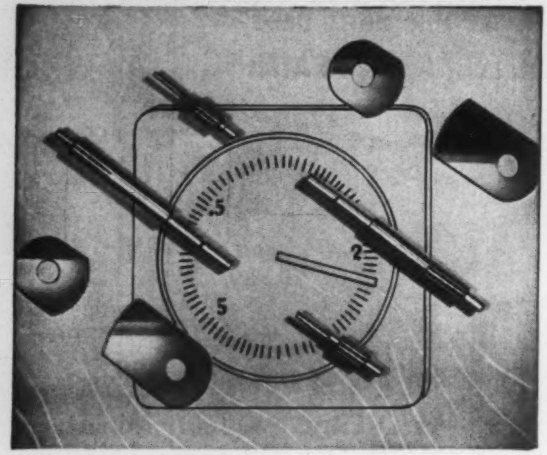

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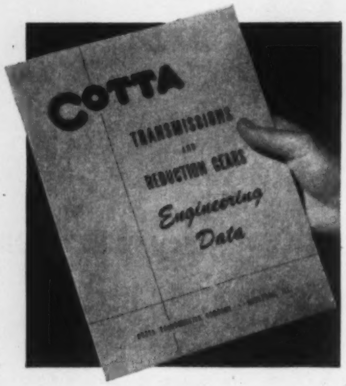

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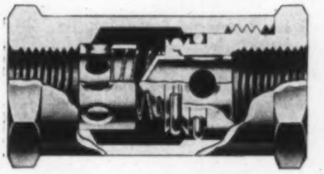

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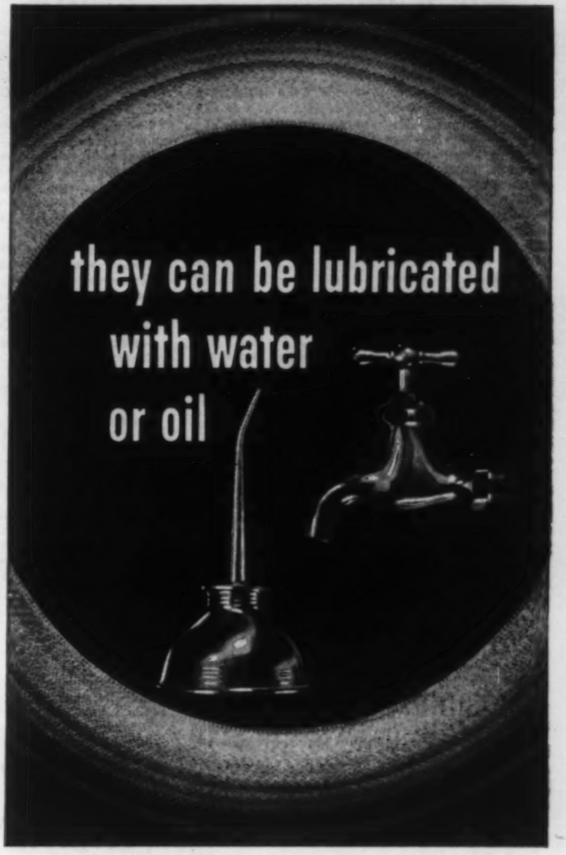

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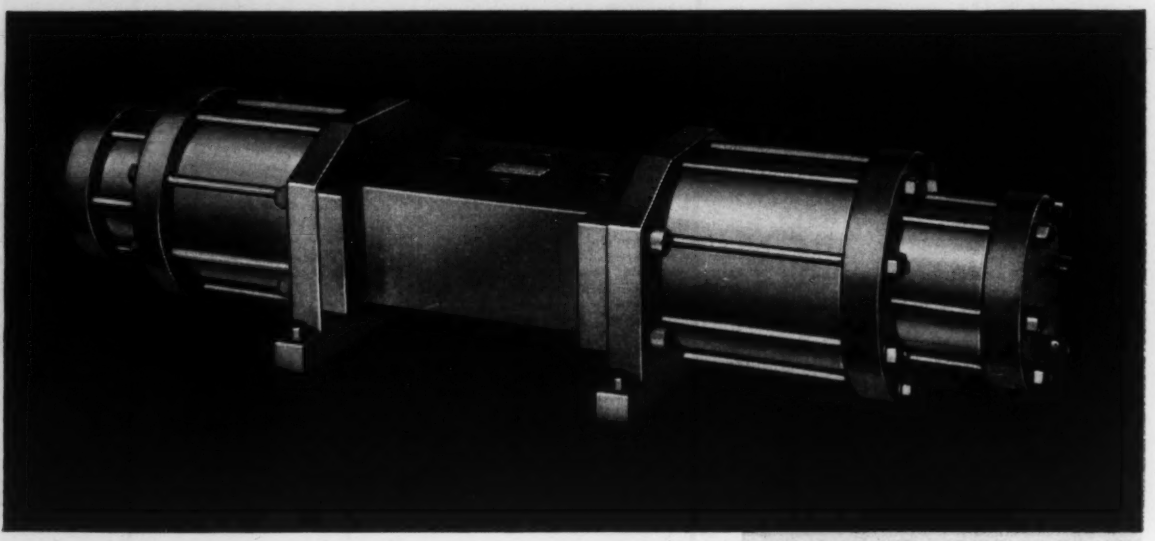
BPA NBP

HUNT
HYDRAULIC VALVES

First Choice in the Steel and other Heavy Industries



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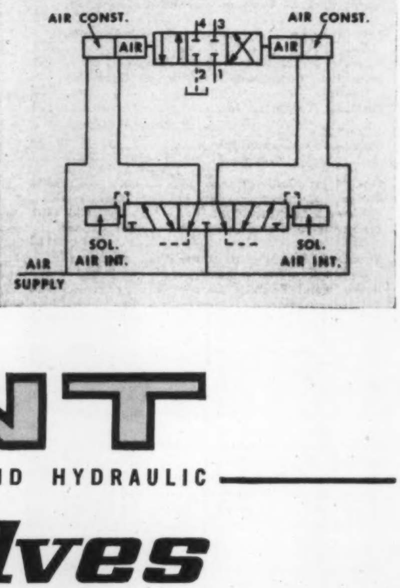
Over 20 years of specialized experience designing—and building—hydraulic operating valves for rugged industry requirements . . . ½" to 8" sizes . . . Zero leakage on water, soluble oil and water, or oil . . . Valves to meet any application . . . No metal to metal seating . . . Easy field maintenance . . . Inexpensive maintenance parts . . . For utmost dependability and service call the Hunt man.

1½" Three Position 4-way Air Pilot Operated 2000 p.s.i. Valve for Oil or Water Service. Other Designs to 5000 p.s.i. Control Circuit Diagram Below Shows Automatic Return to Mid Position.



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HUNT

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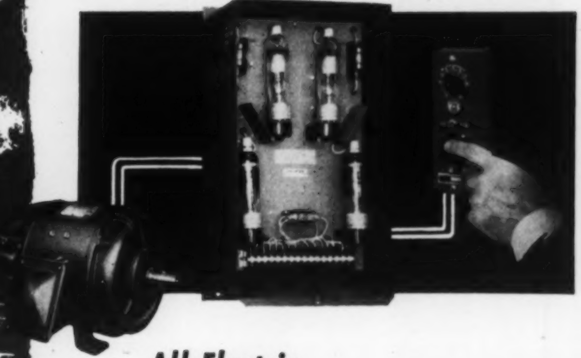
CONTROL Valves

Manufactured by HUNT VALVE COMPANY, 2012 East Pershing St., Salem Ohio

START
STOP
CHANGE DIRECTION
JOG
WIDE SPEED RANGE

New!

RELIANCE V★S Jr.



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Write for Bulletin D-2505 for complete details.

D-1554

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R
REEVES
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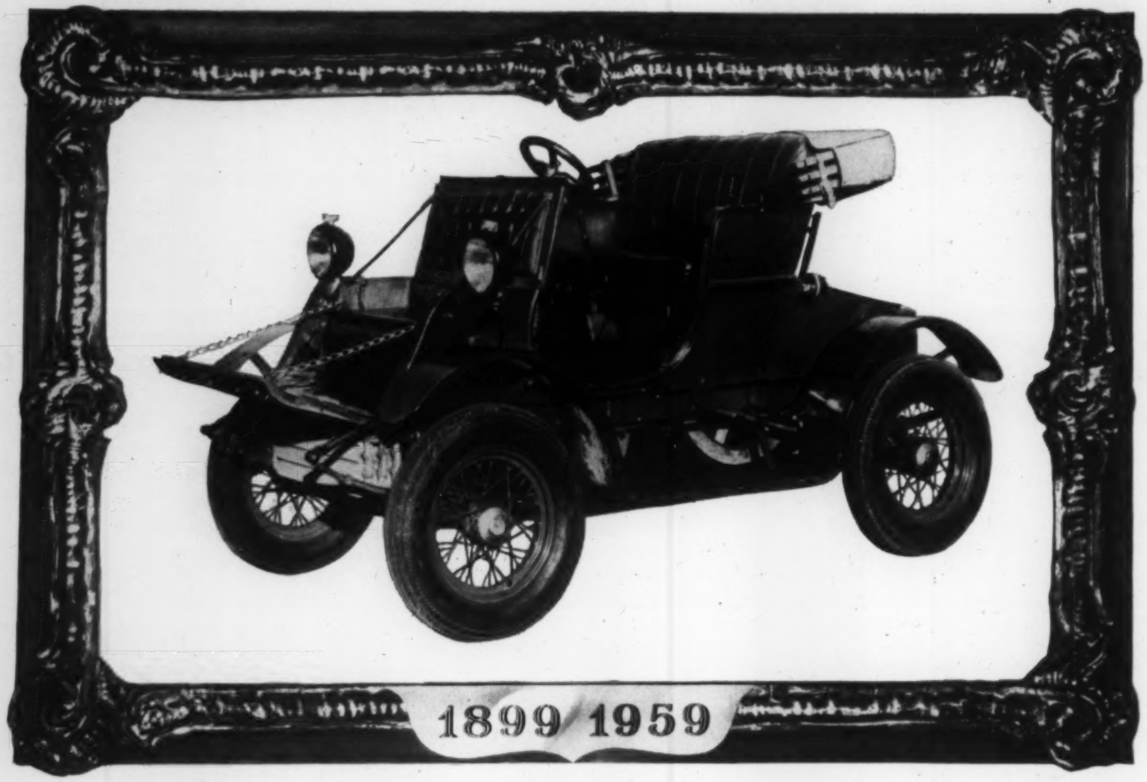

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